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Technical Report 14

INITIATORS AND INITIATING COMPOSITIONS: A LITERATURE SEARCH

Volume I, Unclassified Citations and Abstracts

Alfred M. Anzalone

September 1960

FELTMAN RESEARCH LABORATORIES
PICATINNY ARSENAL
DOVER, NEW JERSEY

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INITIATORS AND INITIATING COMPOSITIONS: A LITERATURE SEARCH

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ABSTRACT

A partial search of the literature on initiators and initiating compositions has been conducted. It covers the reports prepared by Picatinny Arsenal, its contractors, OSRD, and other reports received on initial distribution.

Certain subject areas have been omitted in order to complete this work in the allotted time. They include: artillery primers, pyro-technic igniters, propellant igniters, fuzes, and sensitivity to initiation.

This report is published in three volumes: Volume I (U) covers the unclassified documents, Volume II (S) the classified documents, and Volume III (U) the coordinate index. Preface, Introduction, and Distribution are contained in the first volume.

PREFACE

This report is a partial search of the literature on initiators and initiating compositions. The sources covered are all part of the collection of the Picatinny Arsenal Library. They include all the Picatinny Arsenal reports, those of its contractors, the OSRD reports, and those of other government agencies and private industries received on distribution.

The objective of this report was not to compile a "State of the Art" work on initiators and initiating compositions. Such a complete search will be made at a later date after the techniques used in preparing this work for publication have been thoroughly investigated and reviewed.

To define the scope of this work, a list of subject headings was drawn up. This list took on such proportions that it soon was abandoned. A look at the index should prove this point.

In lieu of such a list of headings, it was decided to enumerate those subject areas which are <u>not</u> covered. They are as follows: artillery primers, gun primers used in ammunition larger than 20 mm, propellant igniters, power sources, pyrotechnic delays and compositions, fuzes and fuze developments, shaped charge initiation, boosters, sensitivity to initiation, black powder, initiation as effecting detonation wave shape, and radiography of detonation wave effects. Also left out were areas covered by previous searches such as Silver Azide (Picatinny Arsenal Literature Search No. 9), Pyrocore Igniter (Picatinny Arsenal Literature Search No. 8), and the Fuze Catalog (The Franklin Institute). Finally, OCTM'S and Ordnance Board Proceedings were also omitted.

The format used in this publication is a composite of several previously used techniques. To use a photo-offset process most effectively it was decided to put all citations with abstracts on the front of 5 x 8 cards which were pre-lined for uniformity. The back of the cards was used solely for listing coordinate terms.

Some variation in citation format and margin indentation will be noticed. These are the result of a gradual development of a style manual for preparing literature searches. Such a manual has now been prepared and future publications will profit from its use.

The abstracts also reflect compromises made in the interest of economy, practicality, and time. Reports containing information abstracts specific to the field of initiators and initiating compositions and not of peripheral interest were copied intact. All other reports were abstracted by the author or by one of several other persons when intitals appear after the abstract. Grateful acknowledgement is extended to these men who volounteered to do this work in addition to their other duties. They are: Mr. Bob Hatch - a technical editor, Mr. Victor Siele - a chemist and Mr. Maurice Warman - also a chemist. Appreciation is also extended to Dr. Harold Matsuguma and Mr. Jack Noonan, supervisors of these men, for enlisting their support.

The abstracting of contract reports took considerable time. These reports were scattered about because of a system by which accession numbers were assigned to individual progress report as received. (A new system has since been set up which assigns one number to all reports on a given job even across contract numbers.) The old system increased the search time per abstract from an average of several minutes to several hours, and sometimes even to a day or more. Once collected, reports were reviewed in mass, nondata reports destroyed, and all others bound together. The completed work was then abstracted. To cover these reports adequately it was necessary to use several 5 x 8 cards for each abstract.

All Uniterms were assigned by the author even those abstracted by other persons. The value of this step, made primarily to maintain consistency, now seems dubious. Without a master vocabulary as a guide, there was no obvious way to control the uniformity of terms selected. This flaw was magnified by the usual lack of standardization among writers in describing similar work, items, or materials. It soon became obvious that a large editing job would be required for the finished index.

It was decided at this point to seek mechanical or semi-mechanical means for editing the Uniterms. A system to do so was found in Univac. Machine alphabetization and frequency count tremendously simplified the task of establishing the master Uniterm list as presented herein. Now available, this vocabulary will be used in any further literature search in this subject area.

This report has been divided into three volumes to ease publication and to permit greater versatility. Volume I (U) consists of preface, introduction, and all unclassified citations with their abstracts. Volume II (S) contains the classified citations with their abstracts. Volume III (U) is the Index.

Citations in both Volumes I and II are arranged alphabetically by corporate author or personal author. Multiple citations by the same author are listed chronologically.

INTRODUCTION

The initiator is an end item which has continued to be of great importance to Ordnance design during the transition to modern weapon systems (guided missiles, atomic warheads, etc.). Regardless of the device to be used or the payload to be delivered, a triggering mechanism is necessary to set off a warhead, demolition, or special device. This fact is adequately borne out by the volume of literature published covering work on initiators.

On 7 May 1956, the Chief of the Ammunition Engineering Branch, Industrial Engineering Division, Picatinny Arsenal, requested that the Technical Information Section compile a bibliography on initiators. According to this request, this Arsenal had been requested by the Chairman of the Explosive Components Subcommittee of the JANAF Fuze Committee (April 1956 meeting) to join with all participating agencies to submit a list of references to reports on initiators so that a complete bibliography could be made available to Ordnance workers.

It had become evident to the members of the Subcommittee that accumulations of scientific and technical information tend to become unwieldly. Previous attempts to retrieve information from various libraries have been disappointing. The use of antiquated tools, such as ordinary file cards or classified report files, has caused many an engineer to frown on literature searches. Indeed, some engineers have taken the seemingly easier path of repeating the work. This step can create costly and needless duplication.

For these reasons, the Technical Information Section recommended an alternate approach aimed at improving the resulting bibliography. A proposal was submitted to the Subcommittee suggesting that a central agency be assigned parent control over this project to avoid needless duplication of source material. Because of the wide inter-Agency distribution of reports,

S U R V E Y Q U E S T I O N N A I R E

ON

THE EFFECTIVENESS OF FORMAT AND INDEXING TECHNIQUES AS USED IN THE LITERATURE SEARCH ON INITIATORS AND INITIATING COMPOSITIONS.

TO BE COMPLETED BY EACH USER ON THE OCCASION OF EACH USE:

1. This literature Search was routed to me on: (Please check one)

   a.-Original distribution_____
   b.-Internal library loan_____
   c.-Other _____

2. Route all future reports on this literature search to me._____Yes_____No.

3. Please answer whether the following are acceptable:

   a. Overall arrangement_____Yes_____No.
   b. Citation Format _____Yes_____No.
   c. Abstracts _____Yes_____No.
   d. Binding _____Yes_____No.

4. It is proposed that the final completed work contain a discussion or "State of the Art" review of the work in this subject area. Are you in agreement that such a need exists?_____Yes_____No.

5. A coordinate term index has been used in preference to a classified subject index or a strict Uniterm index (see introduction in report for reasons). Is this satisfactory with respect to your needs and past experience?_____Yes_____No.

6. In using the index:

   a. The choice of terms was adequate._____Yes_____No.
   b. The exact term desired was listed._____Yes_____No.
   c. It was necessary to coordinate 1 term_____
      2 terms_____
      3 terms_____
      More than 3 terms_____
      (Specify)

7. Please check items used to obtain required information in order of use if more than one was utilized.

   a. Citations----------( )
   b. Abstracts----------( )
   c. Index----------( )

8. Have you read the Preface and Introduction _____Yes_____No. If yes, has the information therein, such as area covered, objectives, sources searched, etc., been adequately presented?_____Yes_____No.

9. Please include any comments you may feel will assist the author in improving the style of these literature searches. Such information would be most appreciated and should be in the form of an indorsement to the attached letter.

SEE REVERSE SIDE FOR INSTRUCTIONS

ORDNANCE CORPS
PICATINNY ARSENAL
DOVER, NEW JERSEY

Mr AMAnzalone/par/73169

IN REPLY
REFER TO:
ORDBB-VS3

SUBJECT: Survey - The Effectiveness of Format and Indexing Techniques as Used in the Literature Search on Initiators and Initiating Compositions

TO:

1. This questionnaire has been prepared to obtain data to evaluate the techniques used in compiling this literature search.

2. A trial period, 1 October -- 31 October 1960, has been set to obtain the data.

3. You are requested to complete the reverse side of this sheet and return it to Mr. A. M. Anzalone, Technical Information Section, Picatinny Arsenal, Dover, N. J. on or before 1 November 1960. It is suggested that individual forms be returned as soon as they are completed.

4. All questions should be answered. If exact answer is not possible, please use reasonably accurate data.

5. If sufficient returns provide usable data, it is planned to report the results of this survey at the Initiator Symposium to be held at The Franklin Institute on November 29-30, 1960.

6. For any comments or extended answers please prepare them as an indorsement to this correspondence.

FOR THE COMMANDER:

M. A. COSTELLO
Assistant

SEE REVERSE SIDE FOR QUESTIONNAIRE

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duplication could run high. It was therefore proposed that a librarian be appointed to supervise the collection of data. It was further proposed that this work be conducted in two phases: Phase I, a search of the holdings of the Picatinny Arsenal Library (this is a relatively short-term project for which funds could be estimated without extended study), Phase II, a search of all Agencies and a compilation supplementing Part I using mechanical means of recording information for future retrieval.

At the April 1958 meeting, the Subcommittee accepted the proposal for Phase I. Action on Phase II was tabled pending the results of Phase I.

The purpose of this literature search, according to the accepted proposal, is to list citations and brief but informative abstracts of each report arranged in a suitable manner. Also, a Uniterm index, as preferred to a subject index, is to be prepared. A Uniterm index provides several times the number of access points to documents and permits a far more specific search than the regular library catalog. As defined, a Uniterm index is neither a subject classification system nor a conventional alphabetical subject index. It is an index where each term has a descriptive word(s) which defines an item (or idea) contained in literature which may have a particular significance in itself or a different significance when combined with another Uniterm. These coordinate terms are arranged in alphabetical order. Under each coordinate term are posted the corresponding report numbers. Numbers are arranged in rows according to their terminal digits. Rapid cross reference is achieved by using two complete sets of coordinate terms side by side.

Altogether there are about 1200 entries with the abstract running over on to extra cards in many cases. The fronts of these cards have been photographed, six on a page, to make an estimated 210 pages (105 sheets) of citation-abstracts alone.

On the back of each abstract card are listed the coordinate terms which average about 20 per card. These have been copied by a Unityper onto magnetic tape to form an input for Univac. Univac alphabetized the terms.

The output tape, coupled to a high-speed printer, was used to print a complete listing of terms and the frequency of multiple terms. This print was used to edit the vocabulary as follows: All plural terms were combined with or changed to the singular except for collective nouns. Misspelled words were corrected. All terms which printed out by number were transposed to print out by letter (example, 20 mm ammunition to ammunition, 20 mm). It was considered to be of prime importance to list terms which with the reader is expected to be familiar. No strict rule has been followed for arrangement with respect to inverted terms, adjectives, or dashes. All have been used. However, whenever possible - that is, whenever the author felt that the term would most easily be retrieved by using a noninverted or a nonhyphenated term - it was so written. See and see also references have been used where terms are synonomous.

All military designations have been listed with the letters or numbers first. All mixtures have been listed with noun first followed by the number. In all cases, the "nothing before something" rule has been followed (example: T18 before T18E3).

These corrections were then made by Univac and a final tape was printed. This tape was then used to print out the index on the high speed printer. Output copy was photo-reproduced.

Both Univac work and photoreproduction were performed by The Franklin Institute. To allow for future rerun or cumulative expansion, the Univac tape was purchased as part of the contract.

1 Aberdeen Proving Ground.
TO DETERMINE THE PERFORMANCE OF PRIMERS, ELECTRIC T44N13, AND M52A2, WITH SHORTENED SUPPORT CUP: by J. A. McKimmey. 29 December 1948 - 19 January 1949. Firing record no. P-44561. OO Project no. TM1-1002B. Unclassified report.

This test was part of the continuation of the general program of improving the electric primer for use with the Gun, Automatic, 20mm, M24. The test encompassed two new types, the Primer, T44N13, and the Primer, M52A2, with shortened support cup. The test procedure included use of the turret for the B36 Bomber; two weapons synchronized to fire at the same instant; and alternate use of two firing circuits. A small group of Primers, M52A2, was tested concurrently. Most of the misfires exhibited less than ten ohms resistance in the gun chamber in which found. Failures to extract were encountered with the prewaxed ammunition. This stoppage was almost completely eliminated by applying a fortifying film of light oil to the cartridges during certain stages.

Neither the Primer, T44N13, nor the Primer, M52A2, with shortened support cup, or design types, should be considered effective for preventing misfires which show characteristic low resistance, approaching short-circuit.

2 Aberdeen Proving Ground.
TEST OF PRIMER, ELECTRIC, M52A3, IMPACT-INSENSITIVE IN GUN, AUTOMATIC, 20MM, M24. 6 July 1951. Report no. 40. Project no. TS3-3014. Unclassified report.

The primer mix of Primer, Electric, M52A3, Impact-Insensitive was compounded with the aim of reducing the dangers of detonation as the result of double feeds. Tests were performed on the primers at both normal and above-normal charging impact energies. A number were impacted the second time. Of the 300 simulated double feeds performed, one primer was detonated while testing at normal charging energy and on first impact. A total of 4447 rounds was fired to determine the gun functioning characteristics of the primers. Data were recorded on misfires, hesitations, primer leaks, and damage to the gun attributable to the ammunition. Five failures to fire were encountered. These stoppages were not misfires, but were evidently caused by momentary short-circuiting of electrical components of external circuit or gun. Six very slight primer leaks were observed.

3 Aberdeen Proving Ground.
A TEST OF CARTRIDGE, PRACTICE, 20MM, T-130 ASSEMBLED WITH LOW VOLTAGE PRIMERS, ELECTRIC, 20MM, M52A3; by R. W. Wood. 27 November 1951. Fifth report on project no. TS1-47.

The subject primed rounds were fired using both d-c and a-c firing circuits with 75 volts being delivered to the primer. Bursts of 50 rounds were fired at this stage to note the effect on breech flash. Notes were also taken on muzzle velocity, rates of fire and representative primer resistances.

It was concluded that the subject experimental primers function satisfactorily at voltages as low as 24 volts d-c or a-c with currents of 500 MA or greater. However, breech flaming was not eliminated completely by the use of this type of primer. (ama)

4 Aberdeen Proving Ground. Ordnance Explosive Disposal Office.
PREMATURE DETONATION OF ELECTRICAL BLASTING CAPS BY INDUCED RADIO FREQUENCY (RF) CURRENTS, by R. E. Clark. January 1956. Memorandum report no. 1, addendum no. 1. ORD project no. TA3-5010-10. Unclassified report.

Reports the results of tests attempting to initiate electric blasting caps by placing them in a radar beam. None of the caps submitted to the tests were initiated. (ama)

5 Aberdeen Proving Ground.
AN EVALUATION TEST OF CARTRIDGE, TP, 20MM, M55 TYPE, PRIMED WITH PRIMER, ELECTRIC, FAT36 (RIVET-TYPE): by J. A. Mahoney. 15 August 1956. Report no. 54 on ORD project TS1-47. Army project 504-05-029. Unclassified report.

The subject cartridges were tested for velocity, pressure, action time and function-and-casualty. It is concluded that the rivet-type primer functioned satisfactorily in the pressure, velocity and action-time tests but its performance was unsatisfactory in the function-and-casualty firing owing to primer leaks, and to one failure to fire which may be attributable to primer malfunctioning. It is recommended that further development be undertaken to eliminate primer leaks before the subject primer is considered for adoption, and that adequacy of ignition characteristics at very low temperature be further investigated. (mw)

6 Aberdeen Proving Ground.
DESERT SUMMER ENVIRONMENTAL FUNCTIONING TEST OF PRIMER, PERCUSSION-ELECTRIC, T106E1, by J. A. Watson. July 1957. Report no. DPS/TB5-1401/392. DPS/TA1-1770/6. Projects nos. TB5-1401, TA1-1770. Unclassified report.

Test objective was to determine the functioning characteristics of the T106E1 Primer under desert summer conditions, when fired in an applicable weapon, using a T106 firing lock.

One hundred MK-15 primers were tested for "go" or "no go" functioning without a propelling charge. Fifty were initiated by percussion and fifty by electricity. One hundred T106E1 primers were tested as follows: 25 initiated by percussion without charge, 25 initiated by electricity without charge, 25 initiated by percussion with charge, and 25 initiated by electricity with charge. The T106E1 primers were tested for "go" or "no go" functioning, obturation, extraction, collection of soot in spindle, chamber pressures, and velocities.

One MK-15 primer failed to function when initiated electrically; it functioned satisfactorily when initiated by percussion. All T106E1 primers functioned satisfactorily. Obturation and extraction characteristics of the T106E1 primers were unsatisfactory. Velocity and pressure dispersions were satisfactory.

Either modification of the T106 firing lock should be made to suit the primer or modification of the primer made to assure satisfactory obturation and extraction characteristics.

7 Aberdeen Proving Ground.
ENGINEERING EVALUATION TEST OF PERCUSSION-ELECTRIC PRIMER AND ELECTRIC PRIMER T107E1, by E. J. Winslow. 11 April 1958. ORD project TA1-1770 - report no. 9. Army project no. 504-03-065. Unclassified report.

This test was conducted to determine the reliability of the T106E1 percussion-electric and the T107E1 electric primers, as to functioning, obturation, and extraction at temperatures ranging from -65°F to -140°F by both percussion and electric initiation. All primers fired, both with and without charge, functioned, obturated and extracted satisfactorily and no primer showed evidence of metal parts failures when fired at chamber pressures up to 46,000 psi. It is therefore recommended that these primers be considered acceptable for use in bag-loaded weapons utilizing the T106 firing lock.

8 Aberdeen Proving Ground.
LIGHTER, FUSE, WEATHERPROOF, T2, by O. L. Rogers. 24 February 1959. Memorandum report no. 1. Project TS1-400. Unclassified report.

This report covers all tests outlined in the engineering test program in PA Technical Memorandum no. 83B24, except for the Jolt and Jumble tests. These were conducted at Picatinny Arsenal. In addition, the low temperature test was rerun with double the number of samples. (ama)

9 African Explosives and Chemical Industries, Limited
IMPROVEMENTS IN OR RELATING TO CLOSURES FOR ELECTRIC DETONATORS. April 10, 1957. Great Britain. Patent specification no. 772,417.

An improved perforated closure plug used for electric and seismic detonators. The plug, which is made of a deformable elastomer and has a single axial perforation through which the lead-in wires are attached to the fusehead, is sealed in the detonator tube by compressing the open end of the charged tube around the plug. A closure of this type reduces gas leakage and water penitration to a minimum. Tests indicate that the closure plug can withstand an internal pressure of 400 lb. per square inch for a period of 10 seconds. (vis)

10 American Cyanamid Company
THE INITIATION OF BOOSTER-TYPE EXPLOSIVES BY LOW ENERGY SPARK DISCHARGES, by J. M. A. deBruyne and J. A. McLean. April 1, 1958. Final report. Army contract DA-49-186-502-ORD-537. Unclassified report.

This final report describes an investigation of possible ways to achieve initiation of booster-type explosives by low energy spark discharges thus eliminating the need for primary explosives.

Initiated into high order detonations by low energy spark discharges were: PETN and Zr or Ti mixtures w/confinement; RDX - Zr mixtures w/confinement; and tetryl - Zr mixtures.

Attempts to detonate these explosives alone, were unsuccessful except for isolated instances where over 1 million ergs was applied. The addition of Zr or Ti metal greatly reduced the energy necessary for firing.

Confinement was found to be a requirement for high-order detonations.

11 American Machine & Foundry Co.

STUDIES OF INTERIOR BALLISTICS OF CARTRIDGE ACTUATED DEVICES. 1 May 1954. Progress report no. 8. Projects TS1-15; AMF proj. MR 1007. Army contract no. DA-30-0690ORD-1251.

Analysis of interior ballistics of initiator system. Test firings with AMF initiator assembly which is similar to M3 Initiator. Detailed description of this initiator is given. Mathematical formulae developed on pressures are given.

12 American Machine & Foundry Company.

PRODUCTION ENGINEERING STUDY: PACKAGING NON-ELECTRIC TYPE ORDNANCE INITIATORS, by J. M. DeMasi. September 15, 1958 to October 15, 1958. Engineering report no. ER 196. ORD project no. PA-63-3. Army contract no. DA-19-059-501-ORD-2765. Arsenal control no. OAC-57-89. Unclassified report.

This report describes a study to investigate automating the packaging of non-electric type initiators such as detonators, primers, relays, and delays; which are presently produced on Jones Loader semi-automatic machinery and which are being investigated for fabrication on a Mass Loader line being developed at the Lone Star Ordnance Plant, Texarkana, Texas.

A preliminary engineering study has disclosed that the two basic systems, a Parellel-Feed Concept and a Series-Feed Concept appeared to be the most applicable from the point of design. They are each predicated on the fact that the subsidiary equipment will be developed for receiving and properly orienting initiators from the Jones Loaders and feeding them into the described systems.

Investigation of these systems has yielded data supporting the Parallel system and just about eliminating the Series system. (ama)

13 Arkansas. University.

STUDIES OF THERMAL DECOMPOSITION OF PERCHLORATES AT CONSTANT TEMPERATURES AND PRESSURES, by T. A. Rodgers and C. J. Wassink. 1 September 1954 to 31 January 1958. Monthly progress reports 1 thru 12 and final summary report. Army contract no. DA-23-072-ORD-1049. Army project no. 599-01-044. ORD project no. TB2-0001. OOR project no. 1171. Unclassified reports.

The thermal decomposition of potassium perchlorate at constant pressure proceeds by a first order solid phase reaction, followed by a first order liquid phase reaction; during the interval of phase transition both reactions occur simultaneously. The kinetic data obtained under various conditions of constant pressure of oxygen indicate that the mechanism of the decomposition is essentially independent of oxygen pressure. Decomposition studies using radiochemically tagged potassium chlorate offer conclusive proof that potassium chlorate, formed in the decomposition of potassium perchlorate, reforms potassium perchlorate in one of its subsequent reactions. Potassium chlorate undergoes no phase changes in the solid phase over the range from room temperature to its melting points. In the isothermal decomposition of potassium chlorate at 500°C under constant pressure, the rate of disappearance of potassium chlorate as well as the rates of appearance of potassium perchlorate, potassium chloride, and oxygen are apparently zero order with respect to mole fraction of the component in each case. The rate of change in concentration of potassium chlorate during isothermal decomposition is the sum of a rate of the chemical reaction and a rate due to changes in volume of the system with time. At 500°C the potassium perchlorate formed in the decomposition of potassium chlorate probably accumulates in the reaction mixture without undergoing appreciable decomposition.

14 Armament Research & Development Establishment. Great Britain.

THE CLASSIFICATION OF SOME DEMOLITION DETONATORS BY PRESSURE BAR TESTS, by E. D. H. Davies and S. C. Hunter. August 1958. ARDE memorandum report no. (MX) 53/58. Unclassified report.

Tests on several demolition detonators were carried out using a Hopkinson pressure bar with electronic recording. The detonators are classified in terms of the momentum imparted to the bar on detonation. The inherent disadvantages of the use of pressure bars for this purpose are discussed in terms of wave propagation along bars.

15 Armament Research & Development Establishment. Great Britain.
THE X-RAY DECOMPOSITION OF ALPHA LEAD AZIDE, by G. Todd and E. Farry. July 1959. ARDE report no. (MX) 17/59. Unclassified report.

Early X-ray damage is accompanied by an increase in certain lattice parameters consistent with the creation of lattice vacancies. The crystals become liable to decrepitate with heat and show an increase in hardness. Up to the equivalent of half a Mohs unit has been noted for the (0 1 3) form. The defect lattice tends initially towards an oriented lead product but is apparently blocked by reaction with the atmosphere. It reacts with water to produce gaseous oxygen and nitrogen but no detectable hydrogen.

Greater X-ray dose can produce severe damage, 98% destruction of a Service sample having been observed after a dose of 3.35×10^8r. There is a weight loss, a volume increase and a large anomalous expansion along the original azide b-axis direction. In air, the solid decomposition product is disoriented basic lead carbonate of formula $2PbCO_3 . Pb(OH)_2$. In the absence of carbon dioxide but presence of water, the product is basic lead azide of unknown formula. In the absence of both the produce is apparently lead.

16 Armament Research Department. Great Britain.
MECHANICAL AND THERMAL PROCESSES OF INITIATION, by A. R. Ubbelohde. October 1943. ARD explosives report no. 336/43. AC report no. 5241. Unclassified report.

The object of the investigation was to extend information on the sensitiveness to mechanical action of initiators, and to examine its relation to thermal sensitiveness. The results have a practical bearing on the mitigation of accidents with initiators, as well as on the 'pick up' of service initiators.

The observations on grit friction support the previously proposed theory that in this type of mechanical action the 'trigger reaction' involves the formation of 'hot spots' between the grit and a hard surface. These 'hot spots' acting on the initiator, generate the detonation wave more easily with lead azide than with mercury fulminate, so that lead azide is more sensitive to grit than mercury fulminate.

Observations on percussion sensitiveness give some support for the previously proposed view that the mechanical action involved is complex, possibly including a tribo-chemical 'trigger reaction' as well as the formation of hot spots through friction. This interpretation of percussion sensitiveness is not finally settled, however.

Whereas a trigger reaction involving the formation of hot spots can be closely linked up with the action of heat, tribo-chemical or other mechanical 'trigger reactions' lead to a type of sensitiveness only indirectly related to the sensitiveness to heat. (ama)

17 Armour Research Foundation.
STUDY OF THE CRYSTAL STRUCTURE OF EXPLOSIVES, by L. V. Azaroff and J. W. Buthey November 6, 1956 thru August 6, 1957. Quarterly reports 1-3. Army contract DA-11-022-501-ORD-2291. ORD project TA3-5000A. ARF project A095. Unclassified reports.

The prime objective of this program was to construct an analog computer for the Fourier series' summations used in crystal structure determinations. A new procedure for crystal structure determination was developed. A new explosive, copper chlorotetrazole, was examined by x-ray diffraction methods. Pellets compacted at various pressures (30,000; 32,500; 33,750; 35,000, and 50,000 psi) were examined. From the resultant x-ray diagrams, it was evident that the differences in consolidation pressures had no effect on crystal structure; particle size, and orientation of the crystallites. Thus, the negative conclusion was reached that these characteristics are not involved in the changes in sensitivity which occur with changes in consolidation pressure. (reh)

18 Armour Research Foundation.
INVESTIGATION OF CRYSTALLOGRAPHIC PROPERTIES OF PRIMARY EXPLOSIVES, by John Krc, Jr. and T. A. Erickson. May 1, 1958 thru May 1, 1959. Quarterly progress reports nos. 1-3 and final report no. 3130-4. Army contract no. DA-11-022-501-ORD-2731. ORD project no. TB3-0115A. Unclassified report.

Three tasks were involved in the fulfillment of this contract - (1) to study and, if possible, identify certain unstable solids observed by Dr. Kiyoshi Hattori during the preparation of beta lead azide; (2) to develop and evaluate a shock tube device for studying sensitivity differences in lead azide, and (3) to observe the growth of large crystals of alpha lead azide by cinematography as a means of determining the causes of explosions which had occurred in the past during similar crystal-growing investigation.

Dr. Hattori's observations were verified by microscopic observations and the precipitated solids identified as an amorphous phase of a basic lead azide, possibly hydrated. Fre-

cipitation occurs when the NaN3 concentration substantially exceed the $Pb(NO_3)_2$ concentration.

Shock tube tests of PbN_6 (in the reflected shock region with shock of Mach 1.5 to 8)indicated that such shock tube tests of sensitivity are reasonably accurate and that a boundary region of "go-no go" can be studied by varying reflected shock temperature, reflected shock pressure, and time delay to detection of detonation.

In the crystal growth studies, no detonations were directly observed, but the movies did reveal cracking and apparent healing of the crystals during growth and also, in some experiments an unexplained formation of gas bubbles. (reh)

19 Armour Research Foundation.

DEVELOPMENT OF DETONATORS CONTAINING NO PRIMARY EXPLOSIVES, by R. Stresau, J. F. Weber, and F. W. Cooper. September 1958 to February 18, 1960. Monthly progress reports 1 - 17. Army contract no. DA-11-022-501-ORD-2892. ORD project no. TN2-8109. ARF projects nos. D178, 4178. Unclassified report.

A study was conducted of the feasibility of producing detonators which while conteining no primary explosives, will fire from the discharge of a 1 uf condenser charged to 100 or 200 volts. In the type of detonator studied, a very small quantity of explosive in the form of a slender confined column is exposed to electrically-produced heat. The column, a .005-inch hole running through a pair of brass discs, is separated by a thin layer of insultation. A molybdenum bridge wire extending through the charge was first used, but problems of alignment in the explosive train led to an investigation of a conductive mix consisting of RDX and Shawinigan acetylene black.

80% High order detonations were ultimately achieved, using a conductive mixture loaded at 60,000 p.s.i. above an air gap of 3/16 inch. The initiating column in these detonators was 1/16 inch in diameter and 1 inch long. Full details are given in a drawing enclosed with the sixth report.

Variables studied in the attempt to maximize this effect included the diameter and length of the explosive column, the pressure used in consolidating the explosive, the thickness of the insultating layer used to increase electrical resistance and produce heat and the percentage of acetylene black used in the conductive mixtures.

Specific findings included: that RDX particle size has a marked effect output, and that length of the explosive column is not a critical parameter.

By the end of November 1959, 50 initiators were ready for comprehensive testing (Bruceton type) and a plastic model, with the "Amphenol Polarized" electrical connector had been built and delivered to Picatinny Arsenal. (rh)

20 Army Attache. Switzerland.

TIME-DELAY DETONATORS. 2 November 1954. Report No. 533-54. See ID 1263950(U). Unclassified report.

A report on the development of two time-delay detonators for use in 20 and 30mm direct action fuzes. One is a combination mechanical-chemical time-delay detonator and the second is a chemical time-delay detonator.

The use of a delay detonator in the 20 and 30mm fuzes permits shell bursts to occur in the interior of an aircraft thus giving greater destructive effect than possible when similar projectiles are detonated instantly on contact with the target aircraft. (ama)

21 Army Attache. Switzerland.

TIME-DELAY DETONATORS. 22 April 1955. Report no. 375-55. See also report no. 533-54. See I.D. 1278713(U). Unclassified report.

Provides additional information to R-533-54 with reference to the chemical composition of explosive and delay elements, their construction and functioning.

Delay composition consists of a wet mixture of lead azide, lead oxide, and a metal carbide. Priming charge of lead azide and a base charge of PETN completes the explosive filler of the detonator. (ama)

22 Atkins, L. M.

EXPLOSIVE TIME DELAY SWITCH. May 20, 1958. United States. Patent no. 2, 835, 758.

An electrical explosive time delay switch which is simple in construction, inexpensive to manufacture, reliable and sealed against atmospheric conditions. Consists of an electric primer and a time delay powder train which is ignited by the primer and, in turn, detonates the explosive charge. (vis)

23 Atlas Fowder Company.

ON THE DEAD FRESSING OF TECHNICAL (GRADE) LEAD AZIDE AND MIXTURES IN DETCNATORS, by W. W. Lee, Jr. July 29, 1954. Translation no. RXL-67-75. Translated from EXPLOSIVESTOFFE; January/February 1953: "Uber das mudepressen von technischem bleiazid und mischaatz in sprengkapseln", by Dr. Wilhelm Schneider. Unclassified report

This work completes the following investigations first reported in the previous publication. 1) influence of damp storage on the completed detonator, type B, in which the mixture was pressed in with various high pressures; 2) influence of the size of the mixture on the phenomenon of dead pressing, initiation of the detonation; 3) influence of the ignition flame on the introduction of a detonation to the mixtures; 4) influence of crystal form and size on the decrease of initial strength of strongly pressed technical lead azide. (ama)

24 Atlas Fowder Company.

REFORT ON INVESTIGATIONS OF CAUSES FOR I RIMER LINE DRY HOUSE EXPLOSIONS. (1958). Unclassified report.

Contains findings to date on the possible causes for three primer line dry house explosions of February 3, March 5, and March 15, 1958. In order to evaluate the several possible causes for the three explosions, a series of standard chemical, physical and electrical tests was completed and the results detailed in this report. These results proved inconclusive. In fact it appears the exact cause may never be known. However, it was the opinion of the writer that the use of PVA in the plant should be discontinued as soon as possible substituting DLA. (ama).

25 Aughey, W. H., L. A. Burrows and W. E. Lawson.

ELECTRIC BLASTING INITIATOR. July 13, 1937. U. S. patent no. 2, 086, 527.

An electric explosive initiator the firing circuit of which is provided with a discharging means whereby the susceptibility of the initiator to static electricity is substantially reduced.

26 Babbitt, H. K. and H. A. Lewis.

INITIATOR. July 16, 1935. U. S. Patent no. 2, 007, 959.

An initiator comprising in combination a charge of secondary detonating compound, a charge of primary detonating compound, and a stainless steel shell encasing the compounds.

27 Bain, C. J. and L. R. Carl.

COMPOUND DETONATORS. February 18, 1947. U. S. Patent no. 2, 415, 80r.

A compound detonator comprising a main charge of nitro-compound, a priming charge of lead azide, and an igniter charge consisting of antimony sulfide, potassium chlorate and lead azide.

28 Ballistic Research Laboratories.
SHORT DELAY BAFFLE DETONATORS FOR ANTI-AIRCRAFT CONTACT FUZES, BY J. L. Squier and Louis Zernow. February 1949. BRL report no. 690. Unclassified report.

The principle of the German Baffle-Delay Detonator is analyzed. Experimental data are compared with first order theory and reasonable agreement is found. This enables a fuze designer to carry out the rational design of a short delay detonator (0.0002 to 0.001 second) for use in anti-aircraft projectile impact fuzes which will exploit the improved performance that results from penetration prior to detonation.

Firing pin energy is found to have a serious effect on the measured delay times. Preliminary experimental results are described. It is pointed out that, as a consequence, tests of short delay detonators should be carried out under conditions which simulate target impact.

Instrumentation for the delay-time measurements is described.

29 Ballistic Research Laboratories.
EXPLODING WIRE AND SPARK GAP CENTRAL INITIATOR FOR HIGH EXPLOSIVES, by Robert DiPersio. October 1954. BRL memorandum report no. 851. Army project no. 503-04-002. ORD project no. TB3-0112. Unclassified report.

It has been found that an exploding wire or a spark, used as an initiator of high explosives, can be used to produce essentially spherical shock waves. It is necessary to discharge a large current through either the wire or spark gap in order to achieve detonation. The exact value of current required appears to be a function of the wire type and dimensions and, in the case of a spark gap, in the geometry of the gap. PETN can be initiated more easily if its grain size is small and it should be packed to a high density to achieve complete detonations.

30 Ballistic Research Laboratories.
THE DELAY AND REPRODUCIBILITY OF THE FUNCTIONING TIME OF THE M-36 AND THE M-36A1 ELECTRIC DETONATORS, by A. L. Ferry. January 1956. Technical note no. 1061. ORD project no. TB3-0112. Unclassified report.

The M36 and the M36A1 electric detonators were tested for delay and time-functioning reproducibility under actual firing conditions. The results, which show the superiority of the M36, are tabulated and discussed.

31 Ballistic Research Laboratory.
MINIMUM CURRENTS AND ENERGIES FOR DETONATING M-36, M-36A1 and M-8ELECTRIC DETONATORS, by J. H. Kineke, Jr. April 1956. BRL technical note no. 1071. ORD project no. TB3-0112K. Army project no. 5B03-04-002.

Results of tests on M-36, M-36A1, and M-8 electric detonators are presented in tabular form. Minimum currents for detonation under steady state conditions, and minimum energies for detonation under pulsed conditions, were determined.

32 Bennett, F. D.
"Energy partition in the exploding wire phenomena". In THE PHYSICS OF FLUIDS. v. 1, no. 6. November-December 1958 p. 515.

Ballistic Research Laboratories.

Streak camera and oscillographic circuit-damping data are presented for exploded copper wires varying in diameter from 3 to 8 mils. A maximum of specific shock-wave energy in the induced flow is found at a wire diameter different from that of a minimum in the total damping time of the circuit. This displacement is shown to be caused by the presence of residual circuit resistance. The proof is based on a critical analysis of optimum damping conditions in the exploding wire circuit. A maximum of apparent energy within the contact surface appears at about the same wire diameter as the minimum of total damping time. Discussion of the implications of the Taylor-Lin similarity theory indicates that lack of similarity of the flow is probably connected with the displacement of the maximum energies associated with shock-wave and contact surface.

33 Blinov, A. B.
"Initiating substances." In his: KURS ARTILLERII (ARTILLERY COURSE), v. 2, Chapter 2. Moscow. 1949.

Describes such initiating substances as: mercury fulminate, lead azide, lead styphnate, and tetracene. Gives the properties of each and how they are employed.

Note: - Complete set of 12 vols. available in Library of Congress. First 2 vols deal with explosives and propellants; other 8 vols. deal with ammunition, weapons, ballistics, firing data, etc. (ama).

34 Board of Trade, German Division (Documents Unit). Great Britain.
MANUFACTURE OF FUZES AND DETONATORS, by Dynamit-Actien-Gesellschaft, Troisdorf. 25 February 1947. P. B. report no. 95613. Unclassified report.

Consists of two files of reports and drawings emanating from Dynamit A. G. and referring to the manufacture of fuzes and detonators. Included are details on the manufacture of: metal shells, priming drops, delay compositions, electric fuzes, triazin, lead trinitroresorcinate, lead azide, mercury fulminate, tetrazene, tetryl and PETN.

The sections are each contained in a separate folder, and also contain flow-sheets and drawings illustrating the matter treated therein. (ama)

35 Boeing Airplane Company.
EXPLOSIVE NUT ENVIRONMENTAL TEST, by P. J. Fantin and R. Winters. 23 March 1955. Test report no. T-29231. Unclassified report. Contract AF33(600)22119.

This test was conducted to determine whether the blasting caps and nuts used to jettison B-52 wing tanks are deleteriously affected by B-52 environmental conditions. The test specimens were subjected to high and low temperatures, altitude, shock, vibration, and humidity conditions equal to or greater than those expected during operation of the B-52 airplane.

It was concluded that: E-77 and E-81 blasting caps are not sensitive to shock decelerations up to 1000 g's; also are not sensitive to vibration within the frequency range of 75-2500 cycles/sec at 15 g's acceleration; vibrations for durations of 100 hrs at these conditions will not deleteriously affect the detonation characteristics of subject caps; shock decelerations up to 1000 g's on these caps subjected to the above vibration, will not detonate the caps; the nuts, when ruptured by their respective blasting caps at 60,000 ft and temperatures from -67°F to 80°F will not emit fragments; the detonation characteristics of these caps while subjected to temperatures of -80°F to 160°F, 100% humidity and pressures equivalent to 60,000 ft, are not deleteriously affected. (ama)

36 Bostrum, A. G.
PROCESS FOR THE PREPARATION OF LEAD AZIDE. September 11, 1957. Great Britain. Patent specification no. 782,715.

An improved process for the preparation of dextrinated lead azide. The improvement is characterized by the following: (1) the reaction temperature is held between 65°C and 90°C, rather than the usual 55°C and (2) the ratio of alkali azide to lead nitrate is no greater than 1.5 to 4 equivalents. Results indicate that lead azide prepared by this procedure has superior initiating and loading capacities. The product also appears to be more homogeneous. (vis)

37 Bowden, F. P. and O. A. Gurton.
"Birth and growth of the explosion in solids initiated by impact." In NATURE. v. 161, no. 4088. March 6, 1948. p. 348.

Reports the investigation of the growth of explosions in solids initiated by impact. The authors have found that a two stage transformation takes place. The original speed of explosion initiated by impact is 400 meters per sec. This is suddenly transformed into a faster detonating rate of 18,000 meters per sec. This phenomenon was first observed in liquid explosions. The work has been continued to include PETN, lead azide and mercury fulminate. A similar initial slow rate of detonation and a very sudden speed up has been observed.

38 Bremer, Bert.
BRIDGE WIRE. May 11, 1937. U. S. Patent no. 2,080,110.

An alloy for resistance units comprising rhodium, ruthenium and platinum in the proportions of 2 to 25% rhodium, 2 to 15% ruthenium, and the balance platinum.

39 Brimley, K. J. and J. C. R. Cance.
IMPROVEMENTS IN OR RELATING TO THE METHOD AND APPARATUS FOR FIRING BLASTING CHARGES WITH A DELAY PERIOD BETWEEN SUCCESSIVE DETONATIONS. 8 February 1956. Great Britain. Patent no. 744, 531.

Method of successive firing of blasting charges with a delay period between successive detonations. Consists of a series of electrically actuable delay switches, each having a fusehead within a container. The fusehead consists of an electric resistance wire and a combustible composition which ignites to yield hot gases. The ignition composition is spotted directly on the switch contacts (bridge wire supports). Ignition of this composition, and the gases subsequently generated, create a conducting path between the switch contacts for the passage of an electric firing current to the next detonator. (jp, amal).

40 British Intelligence Objectives Sub-Committee.
DETONATOR FACTORY, D. A. G. TROISDORF, by W. Taylor and J. S. Forbes. (no date) BIOS final report 644, item no. 2. Unclassified report.

The object of this visit was to investigate the modifications in manufacture and development of new products during the war. The principal types of detonators manufactured were electric detonators mostly of the gasless delay type used in mining coal. The essential feature of the Eshbach type of gasless delay detonator is that no gas escapes until the final explosion of the detonator. Risk of pre-ignition of the explosive by sparks or flame from the fuzehead or burning delay composition is thereby prevented. A detailed procedure for manufacture is given.

Additional developments at Troisdorf during the war and discussed in detail are: manufacture of delay detonators; new fusehead assemblies for delay detonators; new method of closure of gasless delay detonators; improvements in delay unit of gasless delay detonators; modified compositions of Eshbach fuzeheads; methods of handling and mixing initiating explosives; double fuzes for acoustic mines; manufacture of pentaerythritol tetranitrate; new priming compositions. (amal)

41 Bryant, J. I. and M. D. Kemp. (E. R. D. L.)
"The simultaneous polarographic determination of lead azides in aqueous media." In PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. 11-14 August 1959. Eighth conference held at Boulder, Colorado. pp 27-40. Unclassified report.

A polarographic method was developed which provides a safe and effective technique for simultaneously determining both lead ions and azide ions. Its accuracy -- of the order of 1% -- exceeds that of most "wet" methods and compares favorably with the accuracy of other instrumental techniques. The method is rapid, taking about 15 minutes. Safe low concentrations can be effectively determined. The polarographic method was standardized by gravimetric determination. (reh)

42 Bureau of Mines. Department of the Interior.
Investigations of detonators and electric detonators, by Clarence Hall and S. P. Howell. Washington, 1913. Bulletin 59.

At the request of a manufacturer of permissable explosives, an investigation was undertaken by the bureau to determine the relative strength of detonators and electric detonators having different compositions. The conclusions are presented as a service to those using explosives by enabling them to select the grade of detonator or electric detonator that will insure the most effective results. This bulletin is one of a series of publications dealing with the testing of explosives and the precautions that should be taken to increase safety and efficiency in the use of explosives.

The results of the tests emphasize the importance of using explosives in a fresh condition, but as fresh explosives cannot always be had, strong detonators should be used to offset any deterioration of explosives from age.

Also included are such valuables as: a short discussion of the theory of detonation, a description of test procedures used and tables of the results obtained, and the relative strength of detonators and electric detonators. (amal).

See Bulletin 59

43 Bureau of Mines.

THE SAND TEST FOR DETERMINING THE STRENGTH OF DETONATORS; by C.G. Storm and W.C. Cope. Technical paper no. 125. Unclassified report.

In connection with the investigations of explosives conducted by the Bureau of Mines, it is important that suitable tests be devised for determining the relative strengths of detonators, or the comparative ability of different grades or types of detonators to bring about the complete detonation of blasting explosives.

In 1913 the writers began a systematic investigation of the sand test for determining the strength of detonators, and believe that the results presented herewith justify the acceptance of this method of testing detonators as a reliable means of determining the relative efficiency of the different grades of commercial detonators. (ama).

44 Bureau of Mines.

REPORT ON THE ANALYSIS OF INDIVIDUAL FULMINATE PRIMERS, by J. M. Braham, et al. April 16, 1918. Report no. 1. Unclassified report.

Describes the progress to date for the quantitative analysis of the various types of primers in connection with the subject investigation. Methods for the determination of mercuric fulminate and antimony sulfide in fulminate primers have been developed and the potassium chlorate calculated by difference. A direct determination of KCLO3 would be desirable but no satisfactory method has yet been found although some work was done on the problem. The chief reason for this lies in the difficulty of determining it in the presence of the other constituents of the primer and in separating it from them. (ama).

45 Bureau of Mines.

IGNITABILITY OF EXPLOSIVES BY STATIC ELECTRICITY, by D. J. Kusler and F. W. Brown. November 26, 1943 Technical note no. 23. Unclassified report.

Progress to date on the ignitability of explosives by static electricity. Preliminary results of ignition tests made on a number of unconfined explosives and metal dusts subjected to a single discharge over a range of 500-3500 volts are tabulated. A maximum energy value at which no ignition occurs has been determined on each explosive sample. The results indicate that lead styphnate and magnesium compounds are more sensitive than any of the other materials tested and that the sensitivity of mixtures is determined by the most sensitive ingredient. Data also indicates that lead azide, lead styphnate, smokeless powder, magnesium powders, tetracene and ammonium picrate could be ignited by a spark from an individual. (vis)

46 Bureau of Mines.

IGNITABILITY OF EXPLOSIVES BY STATIC ELECTRICITY. II. TESTS ON CONFINED SAMPLES, by D. J. Kusler and F. W. Brown. May 5, 1944. Technical note no. 31. Unclassified report.

Progress to date on the sinsitivity of partially confined and unconfined explosives and metal dusts toward ignition by a static spark. Partially confined materials were investigated at 1500 and 5000 volts, while unconfined materials were examined at 5000 volts. Results indicate that these materials can be classified, with respect to static hazard, as either dangerous or possibly dangerous. Mercury fulminate, lead azide and lead styphnate, are regarded as dangerous while tetryl, tetratol, ammonium picrate and black powder are possibly dangerous. (vis)

47 Bureau of Mines.

STATIC SPARK SENSITIVITY OF MERCURY FULMINATE, by D. J. Kusler and F. W. Brown. January 16, 1945. Technical note no. 44. Problem PC-451 H. Unclassified report.

Static spark sensitivity tests have been made on four samples of mercury fulminate from three different sources. The purpose was to ascertain whether there might be appreciable differences in the sensitivities, and whether it is possible to remove mercury fulminate from the list of those materials which are considered as capable of being initiated by the static charge that can be built up and discharged from an individual.

On the basis of 100 trials at each energy the four samples investigated in the present series of tests gave ignition probabilities ranging from 0.03 to 0.04 at 0.062 joules energy. The differences between samples in the present series of tests would not appear to be significant, and may be statistical. The lowest energy at which ignitions were obtained was 0.031 joules, and in no case were ignitions obtained at 0.025 joules. It would appear therefore, that none of the samples of mercury fulminate would ignite at what has been chosen as the safe limit, 0.015 joules. (ama).

48 Bureau of Mines.
SENSITIVITY OF EXPLOSIVES TO INITIATION BY ELECTROSTATIC DISCHARGES, by F. W. Brown, D. J. Kuslers and F. C. Gibson. January 1946. Report of investigation no. 3852. Unclassified report.

The Bureau of Mines was requested to obtain information on static electrical hazards associated with the handling of explosives or potentially explosive materials. Considerable data has been accumulated but much of this data, being classified, has been withheld from this report. Presented briefly, is some information on the apparatus and techniques and the following general trends observed from the orienting tests and the routine tests.

1. The energy for ignition varies with voltage and over-voltage, but the trend of variation is not the same for all explosives. This conclusion is based upon a large number of orienting tests, the results of which are not tabulated in this report.
2. Large particles ignite less readily than smaller particles, although for some explosives under confinement this effect is not appreciable.
3. Except for primary explosives, the degree of confinement usually has a marked effect upon ease of ignition and completeness of propagation of the ignition.
4. The ignition of secondary high explosives unconfined are apparently explosions of fine dust dispersed into the air by the spark, whereas under confinement these explosives detonat
5. The ignition energies for unconfined samples of finely ground secondary high explosives were invariably less than for the same types of samples under confinement.
6. Metal powders are more sensitive when tested unconfined.
7. Black powder is much more sensitive when tested under confinement.
8. Moist black powder (up to 7% moisture) is more sensitive than dry black powder when tested under partial confinement.
9. Results to date indicate that less energy is required for ignition with a positive point, probably because corona losses are less. (ama)

49 Bureau of Mines.
SENSITIVITY OF EXPLOSIVES TO INITIATION BY ELECTROSTATIC DISCHARGES, by F. W. Brown, D. J. Kusler, and F. C. Gibson. September 1953. Report of investigations no. 5002. Unclassified report.

An apparatus for testing explosive for sensitivity to electrostatic discharges is described in detail. The explosive is subjected to the spark discharges from a series of condensers charged to a predetermined high voltage. Each condenser operates at a different energy level, and, by gradually increasing the energy, the minimum level at which initiation occurs is determined.

On the basis of a series of tests of the apparatus, a set of standard conditions for use in comparing the sensitivities of different explosive materials was worked out.

Among conclusions reached in these tests were the following:
1. Voltage and overvoltage affects the amount of energy needed for initiation.
2. Large particles ignite less readily than small particles.
3. Except with primary explosives, degree of confinement markedly affects ease of ignition and completeness of propagation.
4. Ignitions of unconfined secondary high explosives are apparently explosions of fine dust dispersed in the air by the spark. Under confinement, such explosives detonate.
5. Metal powders are more sensitive when unconfined.
6. Black powder is more sensitive when confined.
7. Moist (up to 7%) black powder is more sensitive than dry black powder when tested under partial confinement.
8. Less energy is required for ignition with a positive point probably because corona losses are less (rh)

50 Burrows, L. A.
ELECTRIC BLASTING INITIATOR. July 13, 1937. U. S. Patent no. 2,086,530.

An electric blasting initiator containing an ignition composition comprising a lead salt of a nitrophenol, the firing circuit of said initiator being provided with a means whereby the susceptibility of the initiator to static electricity is substantially reduced.

51 Burrows, L. A.
ELECTRIC BLASTING INITIATOR. July 13, 1937. U. S. patent no. 2,086,532.

An electric blasting initiator containing an ignition composition comprising silver azide, the firing circuit of said initiator being provided with a means whereby the susceptibility of the initiator to static electricity is substantially reduced.

52 Burrows, L. A.

IGNITION COMPCSITION. July 13, 1937. U. S. Patent no. 2,086,533.

An ignition composition in an electric blasting initiator, comprising at least one of the compounds selected from the group consisting of the silver and mercury derivatives of chlorinated azodicarbonamidine.

53 Burrows, L. A.

ELECTRIC BLASTING INITIATOR. September 19, 1939. U. S. Patent no. 2,173,270.

An electric blasting cap of the bridge plug bead type comprising a charged metal shell, a firing circuit, and an ignition composition comprising a double salt of lead hypophosphite with lead nitrate, the bridge wire of said firing circuit being embodied in a bead of said ignition composition, said firing circuit being provided with a discharging means in that each leg wire of said firing circuit is bent away from the shell wall at a point between the place of emergence of said wire from the plug material and the locus of the ignition bead, permitting the harmless discharge of static electricity to the shell wall at a point outside the locus of said ignition bead.

54 Burrows, L. A

IGNITION COMPOSITION. September 19, 1939. U. S. Patent no. 2,173,271.

An ignition composition comprising calcium hypophosphite and an oxidizing agent.

55 Burrows, L. A.

INITIATING EXPLOSIVE COMPOSITION. March 5, 1946. U. S. Patent no. 2,396,152.

A blasting cap comprising a base charge and a single superposed charge comprising a free-flowing composition composed of coherent aggregates comprising crystals of diazodinitrophenol intermingled with a solid nitrated polyhedric alcohol of the formula $C_mH_{m+2}OH$, said superposed charge being a combined ignition means and primer for the base charge, said charge being approximately twice the amount necessary for priming said base charge, and being characterized by the property of burning instead of detonating when confined only by the cap shell and of detonating when confined by the insertion of a fuse in the cap.

56 Burrows, L. A. and W. F. Filbert.

IGNITION COMPOSITION. October 10, 1939. U. S. Patent 2,175,249.

In an electric blasting initiator of the delay type, an ignition charge in the form of a bead surrounding the bridge wire, which charge comprises a complex salt of lead nitrate with a lead salt of a nitrophenol.

57 Burrows, L. A. and W. E Lawson.

ELECTRIC BLASTING INITIATOR. July 13, 1937. U. S. Patent no. 2,086,531.

An electric blasting initiator containing an ignition composition comprising copper acetylide, the firing circuit of said initiator being provided with a means whereby the susceptibility of the initiator to static electricity is substantially reduced.

58 Burrows, L. A. and W. E. Lawson.
ELECTRIC INITIATOR. January 2, 1940. U. S. Patent 2,185,370.

An electric blasting initiator comprising a loaded shell, a plug disposed in said shell, a pair of leg wires extending into said shell through said plug with their ends disposed below said plug, an electric filament disposed between the ends of said leg wires electrically connecting said ends, a coated bead of ignition material spaced from said plug and suspended from said filament, the coating on said bead comprising a hard, substantially non-flexible pressed-resistant material of a hard, solidified melt completly coating said bead of ignition material, said coating material being characterized by a sharp solidification point above normal temperatures.

59 Burrows, L. A. and W. E. Lawson
DELAY COMPOSITION. January 2, 1940. U. S. Patent 2,185,371.

A delay detonator wherein the delay element is charged with a delay composition of predetermined burning speed consisting of an oxidizing agent and a metal component comprising an alloy of antimony with at least one metal whose heat of combustion per unit volume is substantially different from that of antimony.

60 Burrows, L. A. and W. E. Lawson.
BLASTING INITIATOR. June 18, 1940. U. S. Patent no. 2,402,235.

A blasting cap containing an explosive material blended with a water-insoluble metal soap in finely divided form.

61 Burrows, R. G.
IMPROVEMENTS RELATING TO ATTACHMENTS INCORPORATING EXPLOSIVE BOLTS OR THE LIKE. 23 November 1955. Great Britain patent no. 740,984.

Provides the means whereby the force due to the explosion will effect a positive displacing impetus which will sunder the parts connected and ensure the removal of the attached object. It comprises a housing body having a recess at one end and being closed at the other end; a piston having a working fit within the recess, frangible means connecting this piston to the housing; an expandable chamber within the piston; an explosive charge separated from the expandable chamber by the frangible means; and means for attaching the outer end of the piston to the other member so that as the piston is ejected from the recess the piston will positively engage and carry away the other member.

The explosive charge, in the form of a cartridge, containing a detonator having electrical leads connected thereto, may be enclosed within a bolt-like member, the outer end of which is adapted to be affixed to one of the parts to be attached. (ama)

62 Canadian Industries Limited.
ELECTRIC IGNITER FOR FUSE IGNITER CORD. March 28, 1956. Great Britain. Patent specification no. 747,278.

A mechanism which can be used for electrical initiation of fuse igniter cord. Construction specifications are presented. The subject assembly is said to function properly under extreme temperatures and wet conditions. This mechanism eliminates the unsafe practice of manual ignition. The preferred igniter composition used in this device consists of 70% red lead and 30% silicon by weight. (vis)

63 Cance, J. C. R. and K. J. Brimley.
IMPROVEMENTS IN OR RELATING TO THE METHOD AND APPARATUS FOR FIRING BLASTING CHARGES WITH A DELAY PERIOD BETWEEN SUCCESSIVE DETONATIONS. 8 February 1956. Great Britain. Patent no. 744,530.

A short delay method and equipment which permits the selection of 10-100 msec delay times from electrically actuable delay switches. Detonation takes place by passing an electric firing current through the fusehead of each succeeding detonator by way of an electrical delay switch actuated by the firing current of the preceding detonator. This permits the electric firing current to pass through the fusehead when a closed circuit is formed. The electric firing current for each detonator and its associated delay switch is a single impulse from a pulsating electric current in which the period of time between the electric impulses is the same as the delay period between successive detonations. Also, the duration of each impulse is less than the period of a delay switch and is longer than the period of time required to fire a detonator and its associated delay switch. (jp)

64 Chamot, E. M.
THE MICROSCOPY OF SMALL ARMS PRIMERS. Ithaca. Cornell Publications. 1922. 61 p.

A systematic microscopic study of a large number of primers and the investigation into the reasons for primer malfunction. Microscopic data is reported for primer pellets, anvils, cups, coatings and pellet components which includes $KClO_3$, $Hg(CNO)_2$ $Fb(SCN)_2$ and inorganic nitrates such as potassium, ammonium, and barium nitrates.

The results indicate that 73.8 percent of the malfunctions are caused by the following: (1) Defects in assembly and other mechanical imperfections (28.5%) (2) poorly compressed or thick pellets (25.0%), (3) detonating flame and gases not hot enough (12.6%) and (4) segregation of primer components (7.7%). Of the remaining 26.2%, 12.6% are indeterminant and 13.6% can be classified as miscellaneous. (vis)

65 Chemical Inspectorate. Ministry of Supply, Great Britain.
THE POLAROGRAPHY OF LEAD STYPHNATE, by L. R. Leake and G. F. Reynolds. January 1958. C. I. report no. 105.

A study of the polarographic behaviour of lead styphnate has been made. It has been shown that a combination of normal polarography and derivative polarography using an alternating current method, it is possible to determine both lead and styphnate ions in the same solution.

66 Clark, L. V.
INITIATOR AND CAP. August 3, 1943. U. S. Patent no. 2,325,742.

An initiator charge for detonating purposes including a heavy metal salt of nitroaminoguanadine.

67 Cobb, W. M.
DETONATOR OR BLASTING CAP. May 14, 1946. U. S. Patent no. 2,400,103.

In a substantially spherical electric detonator having an electric ignition device, an initiator molded on and concentric with said ignition device, a charge of detonating explosive formed about said initiator and concentric therewith and a protective coating enclosing the detonator.

68 Combined Intelligence Objectives Sub-Committee. U. S. Army.

MANUFACTURE OF INITIATING EXPLOSIVES AND THEIR HANDLING FOR USE IN CAP AND DETONATOR LOADINGS AT FABIK WOLFRATSHAUSEN CHEMISCHER ERZEUGNISSE AND THE STADEN PLANT OF DYNAMIT - ACTIEN - GESELLSHAFT, by L. M. Sheldon. August 1945. CIOS target nos. 2/68 & 2/173. Item no. 2, file no. 27-38 Unclassified report.

A report on the interrogation of Dr. Adelbert Grebel, at Fabrik Wolfratshausen. Described are the methods for the manufacture of initiating explosives and of the cap and detonator loading section. Given also, is information obtained from a similar visit to the Stadeln Plant of the Dynamit A. G. where Dr. Stadler supplied information on these same processes.

This report provides a description of the equipment, buildings and materials used for the manufacture of such explosives as: dextrinated lead azide, tetrazene, lead trinitroresorcinate, lead styphnate, and cap and explosive compositions.

Included in the very good description of manufacture are methods for the chemical destruction of these explosives; also, methods for drying them. (arma)

69 Consolidated Vultee Aircraft Corporation.

DEVELOPMENT OF ELECTRIC PRIMER FOR 20 MM AMMUNITION - SUMMARY OF PERFORMANCE AT CONVAIR, FORT WORTH DIVISION, by J. A. Jones. 16 August 1950. Report no. FZM-36-359. Army contract no. W-35-038-AC7. Air Force contract no. AF-33-(038)-2182. Unclassified report.

Contains summary of data from aerial gun firing tests conducted April 1949 to July 1950. Effects of misfirings, water submergence, and airplane flight vibration on primer resistance are covered by these tests. Two basic types of fire control boxes were used; one to make possible the testing of rounds having 300-ohm-resistance primers. Several units embodying the capacitor-discharge principle were tested. (reh)

70 Cook Research Laboratories.

STUDIES, INVESTIGATIONS, AND EXPERIMENTS ON LEAD AZIDE. 12 June 1957. Final progress report FPR 139-1 for the period January 1, 1957 to May 31, 1957. Army contract DA-44-009-ENG-3189. Unclassified report.

Dielectric constant and loss tangent values at 10,000 mc for a lead azide along the c-crystallographic axis have been obtained that are in agreement with previously reported values. Equipment has been constructed for dielectric measurements at frequencies between 10,000 and 30,000 mc. Judging from the small loss tangent values obtained for a lead azide along the c-axis it is improbable that the number of free electrons necessary to contribute materially to the dielectric constant are present. Heating a-lead azide for 15 hours in an oven at 100°C in 3 hour intervals produced no change in the dielectric properties. One sample split while in a 200°C oven for the first time. A device was constructed to enable small uniform forces to be applied to the lead azide crystal during lapping.

71 Cox, R. F. B.

BLASTING CAP. July 26, 1938. U. S. Patent no. 2,125,221.

A blasting cap for detonating explosives including a casing and a charge of hexanitrodiphenylethylenedinitramine.

72 Crater, W. deC.

BLASTING CAP. September 10, 1940. U. S. Patent no. 2,214,721.

An electric blasting cap containing a base charge of pentaerythritoletranitrate and a priming charge of diazodinitrophenol superimposed thereon.

73 Cushman, A. S.

"Antimony sulfide as a constituent in military and sporting arms primers." In JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY. v. 10, no. 5, May 1918. p. 376.

Contending that antimony sulfide need not be more than 80% pure (18% oxide), that the purity of antimony sulfide should be determined from its sulfur content rather than its antimony content, and that many purity requirements for this material are unrealistic, the author describes and presents the results of a number of experiments.

In 3-oz-weight drop tests, the sensitivity of 100% pure antimony sulfide was found to be only 1/2 inch greater than that of regular sulfide (18% oxide, 2% other impurities).

In ballistic tests, the following findings were made:

	Velocity fps	Pressure lbs
Regular antimony sulfide (18% oxide)	2655	47155
100% pure antimony sulfide	2649	47330
100% pure antimony sulfide plus 18% oxide	2695	47865
Regular antimony sulfide treated with tartaric acid	2697	47615
Lead sulfide (galena) only	2704	47545
Iron sulfide (pyrite) only	2704	47840

It is suggested that other metallic sulfides might, if investigated, be found better than antimony sulfide for use in primers. (rh)

74 de Heer, J. (P. E. C. Corporation)

"Survey of simple valence theory of lead azide." In PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. 11-14 August 1959. Eighth conference held at Boulder, Colorado. pp 41-[illegible]. Unclassified report.

An account of the electronic structure of free and bonded azide radicals and of free azide ions in their ground state, mostly within the framework of the molecular orbital theory. Possible configuration of excited radicals are briefly discussed. Valence properties of lead azide are considered, special attention being paid to its ability to form covalent bonds. Some speculations are made regarding the structure of the lead azide crystal and comments are made regarding the relative roles of theory and experiment in elucidating the properties of lead azide. (reh)

75 Dept. of the Army.

MILITARY EXPLOSIVES. April 1955. Ord. project nos. TM 9-1910, TO 11A-1-34.

A basic source of general and technical information concerning military explosives. Contains information on chemistry, physics, manufacture, properties, identification, handling, use, inspection, preservation, storage, transportation, demilitarization and disposal of military explosives and related substances.

76 Deutsche Waffen & Munitionsfabriken A.G.

ARRANGEMENT FOR ELECTRIC IGNITION. German patent no. D 82 934 XI/72d4. 1 October 1942. Halstead Exploiting Centre translation no. BIOS/Gr. 2/HEC 5422. Translated by Redlich. Unclassified report.

Use of a "creeping spark" for the electrical initiation of detonating compositions is proposed. Such a spark travels two-dimensionally across the surface of a dielectric substance in which small conductive particles are lodged. Such a surface can be created by spreading a varnish containing particles of graphite or metal, by mixing powdered glass into certain explosives or by using such ready materials as conductive rubber. The electrical resistance of the path material must decrease as the voltage is increased. Such a "creeping" spark requires much less voltage for a given distance of travel than does the usual three-dimensional spark. (reh)

77 Diamond Ordnance Fuze Laboratories.

ACCEPTANCE TESTS FOR BS-8 DETONATOR, by G. R. Keehn. 21 October 1954. Informal technical memorandum no. 31.1-TM-19. Unclassified report.

Specifications for initiation of the BS-8 detonator are drawn from the Mk 131 electric primer, U.S. Army Spec. no. 50-78-8; M3 Electric Detonator. The ignition assembly consists of a phenolic plug with graphite bridge, lead styphnate ignition spot, and lead styphnate flash charge in steel ferrule. Upper charge is PETN and intermediate charge is lead azide. (ama)

78 Diamond Ordnance Fuze Laboratories.

MEASUREMENT OF PARTICLE SIZE OF COMPONENTS OF GASLESS MIXTURES, by R. H. Comyn, M. L. Couch and R. E. McIntyre. 28 August 1958. DOFL technical report no. 636. ORD project no. TN 3-9109. Army project no. DA-5NC6-01-010. DOFL project no. 30131. Unclassified report.

The relationships between the blending and burning characteristics of gasless mixtures and the particle size of their ingredients are discussed in detail. Particle size methods used in current pyrotechnic specifications are shown to be inadequate for controlling the size of the ingredients of gasless mixtures. A number of known particle size methods are reviewed and their applicability to gasless mixtures are considered. Two methods are recommended for measuring the particle sizes of ingredients of gasless powders: The Brunauer-Emmit-Teller (B. E. T.; nitrogen absorption) method for determining total surface area, and the Eagle-Picher Turbimetric method for measuring particle size distribution.

79 Diamond Ordnance Fuze Laboratories.

A SOLID-STATE SWITCHING DEVICE, by K. O. Otley, et al. 30 August 1958. DOFL technical report no. 640. Army project no. 506-01-010. ORD project no. TN3-9109. Unclassified report.

Controlled dielectric breakdown of a pure aluminum oxide film, deposited electrolytically on aluminum foil, has been achieved. This anodic film is employed in a solid-state switching device. This device has the properties of a capacitor with a breakdown voltage of approximately 14 volts, a capacitance as low as 0.0005 uf, and a leakage resistance usually in the kilomegohm range. Its initial resistance drops to the order of one ohm or less upon application of its critical voltage. Energy transformation is large since a signal with an energy content of ergs can control watts. Compared to a thyratron, which it may replace in certain applications, the switch is smaller, less expensive, more resistant to shock, vibration, and high-energy radiation, and requires no "A" supply. Use of this switch in the following circuits is described: a time delay, a series arrangement, and stacked arrangements for use at voltages higher than critical.

80 Director General of Ordnance Factories. Great Britain.

REPORT ON A VISIT TO J. MEISSNER, KOLN; AND HAAGEN & RINAU, W. GERMANY: By F. J. Hall. April 1956. Report no. 42. OIN 13308. Unclassified report.

The Meissner process for continuous precipitation of lead azide was the principal subject of discussion at Koln; it falls below our normal standards, both in safety of operation and in quality of product and Meissner are not prepared to make any changes in it. Information concerning plant for continuous manufacture of hexamine and of mono- and tri-nitrotoluene was also obtained.

The Haagen & Rinau "Unimix Gigent" mixer appears to have potentialities for use as an incorporator for mixed high explosives. The firm is willing to modify it to suit our requirements and promise early delivery. Purchase of a 250-lbs capacity mixer is recommended.

81 Drury College.

DETERMINATION OF OPTICAL AND ELECTRICAL PROPERTIES OF SELECTED INORGANIC AZIDES, by J. G. Dodd, et al. Interim technical reports nos. 1-3. 10 December 1958 to 9 September 1959. Army project no. 8-07-11-440. Army contract DA-44-009-ENG-3773. Unclassified reports.

A continuation of the work done under contract DA-44-009-ENG-3427. Chemical investigation revealed that carbonates are present in highly purified sodium azide, that ethylene glycol is a good solvent for sodium azide, and that treatment with acetone substantially increases the purity of sodium azide from 93.7% to 99.2%.

Automatic instrumentation for determining the electrical conductivity of sodium azide was developed, involving use of a logarithmic converter with an electrometer, a thermistor bridge, and a Mandrel X-Y recorder.

An aluminum powder reflectance standard is reported, and a representative graph of the reflectivity of sodium azide vs this new standard is presented.

A model for an excited-state of the azide ion, developed by Dr. Eugene Lieber, is thoroughly discussed, and used in developing a mechanism for photolysis which agrees with observation.

Light leakage nullifying previous positive results of photochemiluminescence analyses is reported. (reh).

82 Drury College.

OPTICAL AND ELECTRICAL PROPERTIES OF SELECTED INORGANIC AZIDES, by J. E. Dodd, et al. 10 December 1957 to 9 December 1958. Quarterly progress reports nos. 1-2, final technical report. Army project no. 8-07-02-004. Army contract DA-44-009-ENG-3427. See ENG 3773 for other work. Unclassified reports.

Single crystals of sodium azide were prepared, purified by osmosis, and then crystallized by evaporation. A study conducted to obtain a detailed model of the photodecomposition of hexagonal sodium azide revealed a photolytic process involving both short time and long-time effects. Studies of photoconductivity, charge carrier lifetime, and electrical conductivity in sodium azide led to the conclusion that photoconductivity in the ordinary sense does not occur in single crystals irradiated with wave length between 200 mu and 400 mu.

A study of the lifetime of charge carriers in photoconductive sodium azide, found the use of exploding wires promising, since the usable spectrum they emit extends down as far as 800A.

The surface reflectance of sodium azide was also studied. Effects of various types of irradiation - from a hydrogen lamp, a G. E. sunlamp, and an ozone lamp - were investigated. In some regions, the irradiation was found to initially enhance the reflectance of the samples, though the values obtained subsequently dropped.

A mass spectrometry study of the thermal decomposition of sodium azide was also conducted, and attempts were made to conduct an investigation of the photochemiluminence of lead azide. (reh)

83 DuFont de Nemours & Co., E. I.

THE BLASTING CAP HAZARD IN MOBILE RADIO, by C. P. Williams. Paper presented before Institute of Radio Engineers, Group for Vehicular Communications, held on October 2?, 1951. Unclassified report.

Discusses an accident whereby a premature explosion of a 5 lb charge of high explosives was caused by a radio transmitter and horizontal antenna.

84 Durant, W. W.

GLASS SEALING PLUG FOR BLASTING CAPS. April 29, 1941. U. S. Patent no. 2,240,438.

An electric explosive initiator including a shell having an explosive charge therein, a plug head including electric lead wires and ignition means, said plug head including a sleeve, a mass of glass within the sleeve and bonded directly to the inside of the sleeve and the outside of the lead wires in a water tight manner, the sleeve being secured to the shell.

85 Dynamit-Actien-Gesellschaft vormals Alfred Nobel & Co.

THE PRODUCTION OF LEAD AZIDE (PbN_6). 2 October 1946. Halstead Exploiting Centre report no. 13026/BIOS/Gp. 2. Military Attache report no. R 2289-47. A translation. Unclassified report.

A British Intelligence Sub-Committee report on the manufacture of dextrinated lead azide prepared from dextrin, lead nitrate and sodium azide. Given are the step-by-step procedures with flow sheet diagrams showing plant layouts. (ama)

86 Dynamit-Actien-Gesallschaft.

IMPROVEMENTS IN OR RELATING TO ELECTRICALLY IGNITED DETONATORS. 2 May 1956. Great Britain patent no. 748,445.

According to the present invention, there is provided an electrically ignited detonator, comprising two electrodes, an incandescent bridge connected across the gap between the poles of said electrode, an initiating or delay composition spaced from said bridge, and means for applying between the poles a sufficient difference of electrical potential to fuse the bridge, thereby forming an electrical arc. The distance between the bridge and the composition is such that ignition occurs only by the arc.

The flame can be produced by means of an incandescent wire which can be exploded or caused to give a high instantaneous arc of flame. The bridge can also be constructed of a conductive lacquer or a very thin metal film.

Pre-ionization of the air in the igniter space between the bridge and the delay or initiating composition enables a large measure of

control to be exercised upon the arc-flame. The ionization may be effected, for example, by the introduction of traces of radioactive preparations into the igniter space. (ama)

87 Engineer Board. Fort Belvoir.

ENGINEERING TEST OF PRESSURE TYPE FIRING DEVICES T-2; by J. P. Roysdon. February 3, 1943. Demolition report no. 9. Unclassified report.

Reports engineering tests carried out on three experimental models of pressure type firing devices T - 2 and one sample of the standard British Anti-Personnel Switch. These devices are commonly known as "Footshooters".

The experimental models of the Pressure Type T-2 Firing Device required a heavier pressure to fire than did the British Anti-Personnel Switch. For this reason they are safer to arm and disarm.

The British switch proved to be the most destructive, but the T-2 proved to be sufficiently destructive to accomplish the purpose for which it was designed. This consideration together with weight, volume and safety factors indicate that the caliber .30 T-2 is the most desirable of all those tested.

88 Engineer Board. Fort Belvoir.

ENGINEERING REPORT ON THE DELAY DETONATOR, by D. J. Andrew. April 28, 1943. Demolitions Branch report no. 25. Unclassified report.

This report deals with detonators of ten and twenty seconds delay respectively, designed to be used for assault work. The assembled detonator consists of a plastic protective case, a cap protector, a safety pin, a pull ring, and a delay assembly which is composed of a fuse lighter, a fuse, and a blasting cap. The fuse in the delay assembly is a gasless thermit type lead fuse.

Results thus far indicate that the delay detonator is dependable, accurate, safe, and waterproof. (ama).

89 Engineer Board. Fort Belvoir, Va.

ALL-WEATHER FUSE LIGHTER, by J. P. Roysdon. 23 November 1943. Project DM 386. Unclassified report.

Development of an all-weather fuse lighter, the Fuse lighter, T2, is described herein. Laboratory and service tests showed the Fuse Lighter, T2, to be a reliable means for igniting safety fuse under the most adverse weather conditions. It is recommended that the Fuse Lighter, T2, be adopted as the M2 and issued on the basis of 20 per squad demolition chest and 50 per platoon demolition chest.

90 Engineer Board, Fort Belvoir, Va.

CONCUSSION DETONATORS, by H. B. Estabrooks. 4 March 1944. Project DM 4c0. Unclassified report.

A description and the results of tests conducted on two types of concussion detonators, H. E. P. no. 3 model and H. E. P. no. 6 model, are contained in this report. The operating range of no. 3 mod. may be considered as satisfactory, but the construction and design of the device make it unsafe for general use. The no. 6 mod. was tested extensively both in air and water with good results in both mediums.

No. 3 detonator is actuated by the fracture of a glass diaphragm whereas the no. 6 detonator is actuated by the elastic snap of a metal diaphragm. Both detonators are armed by the dissolving of a delay salt block. The no. 6 detonator can be used in air by replacing the salt block with a safety pin.

The salt block used (no. 43-30) had an average arming time of 5 min. 24 sec and a safe time of about 3 min.

The device should not be used in depths greater than 12 ft. the depth at which the device fired due to hydrostatic pressure alone. (ama)

91 Engineer Research & Development Laboratories.
VARIABLE DELAY FIRING DEVICE, by J. P. Roysdon. 22 October 1948. ERDL Report no. 1078. Project 8-07-05-001. Unclassified report.

The Navy Mark Model 0 was investigated as a possible substitute for the Firing Device, Delay Type, M1. The Mark 15 Model 0 demolition firing device does not fulfill the requirements of the military characteristics established for Project 8-07-05-001, especially with respect to safty and accuracy. However, this device possesses many desirable features, such as, being small, compact, easy to use, efficiently designed for space conservation, and possesses exceptionally good resistance to weathering and water submersion, operates at a low noise level and is readily adaptable to low cost mass production. It is believed that these desirable features outweigh the faults to the extent that development should be continued and so directed as to embody the basic features of the present design. Also a discussion of the activities and results carried out on mechanical firing device, T-2, is included.

92 Engineer Research & Development Laboratories. Fort Belvoir.
CHEMICAL MICROSCOPY OF EXPLOSIVE AZIDES, by Hyman Rosenwasser. 18 December 1957. Report no. 1507-RR. Project no. 8-07-02-004. Unclassified report.

Characteristic crystal habits of the azides of lead, copper, silver, mercury, and thallium have been obtained by the techniques of chemical microscopy. These crystals are illustrated by photomicrographs.

93 Engineer Research and Development Laboratories. Fort Belvoir.
OPTICAL AND ELECTRON MICROSCOPY OF SODIUM AND POTASSIUM AZIDES, by Johann Joebstl and Hyman Rosenwasser. 27 April 1959. Technical report no. 1577-TR. Army project 8-07-11-440. Unclassified report.

Crystal-habits of sodium and potassium azides have been studied by optical and electron microscopy. The growth features are illustrated with photomicrographs. Observations have also been made on the effects of aging, etching, and heating of these azides.

94 Engineer Research and Development Laboratories.
PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. Prepared by Z. V. Harvalik. 11-14 August 1959. Conference no. 8 held at Boulder, Colorado. Unclassified report.

Representatives of Army, Navy, and both corporate and academic contractors met and heard 27 papers on various aspects of the chemistry of explosives and explosions with particular reference to the azides. Major session topics were - General Problems, Chemistry of the Azides, Crystal Structure of the Azides, Physical Properties of Azides, Effects of Energy Interactions with Azides I, Effects of Energy interactions with Azides II, and Effects of Interactions with Azides III. (reh)

95 Engineer Research and Development Laboratories. Fort Belvoir.
HYDRAZOIC ACID AND THE METAL AZIDES: A LITERATURE SURVEY, by Hyman Rosenwasser. 28 October 1958 - 14 December 1959. Report no. 1551-TR, and supplements. Project no. 8-07-11-440. Unclassified report.

In 1904, Dennis and Brown reviewed the work published up to that time on hydronitric acid and the inorganic trinitrides. Twenty years later, Audrieth (2) reviewed the field with his paper on hydrazoic acid and its inorganic derivatives. With the continuing expansion of research in this field, it is felt that the time has come for another bringing together of information on the subject of azides.

This report covers data presented in the unclassified literature on HN_3 and the metal azides since the report of Audrieth. The main source of information was chemical abstracts. References to the original literature are cited by numbers corresponding to the bibliography at the end of the report. (ama)

96 Evans, B. L. and A. D. Yoffe. University of Cambridge.
"Structure and stability of inorganic azides: II. Some physical and optical properties, and the fast decomposition of solid monovalent inorganic azides." In PROCEEDINGS. ROYAL SOCIETY. Series A: v. 250, no. 1262. March 24, 1959. pp. 346-66.

The stability (isothermal decomposition) to heat and light of a series of monovalent inorganic azides is considered. The stability decreases in the order KN_3, TlN_3, AgN_3, and CuN_3. This is the order of increasing ionization potential of the metal. Measurements have been made on a number of the physical properties of these compounds, such as the refractive indices, absorption spectra, photoconductivity, and melting points. The electron energy levels of these solids has also been estimated. These include the energy (optical and thermal) required to form an exciton and where appropriate the energy required to dissociate the exciton to give an electron in the conduction band. The relation of these measurements to the decomposition mechanism is considered.

The critical light energy required to ignite a pellet of silver azide is reduced by the addition of colloidal gold (or silver). The metal particles are thought to act as electron traps during the initial photochemical decomposition. This increases the extent of the decomposition. The growth of the explosion, however, is a thermal process in which there is self heating of the azide and an accelerated rate of decomposition. A molten phase is probably necessary for the fast decomposition of the inorganic azides.

97 Explosives Research & Development Establishment. Great Britain.
INFRA-RED SPECTRA OF PURE AND PARTIALLY DECOMPOSED METALLIC AZIDE CRYSTALS, by F. W. J. Moore. 18 October 1955. ERDE report no. 23/R/55. Unclassified report.

The infra-red spectra of pure single crystals of potassium, sodium and silver azides of B-lead azide and of the hydrated azides of barium and lithium have been measured at room and liquid oxygen temperatures. The observed bands are attributed to specific vibrational transitions. The azide ion in the univalent salts of lithium, sodium, potassium, and silver is shown to be totally symmetric. No definite conclusions are reached with the bivalent salts of barium and B-lead. The work indicates that the explosive nature of the azide ion is not connected with its symmetry.

The spectra of single crystals of potassium and silver azides, after irradiation with ultra-violet light and x-rays, have been recorded. Specific decomposition centres in the crystals give rise to characteristic absorption bands. No evidence for internal cracks or dislocations was observed in the spectra.

98 Explosives Research & Development Establishment. Great Britain.
THE ELECTROSTATIC SPARK SENSITIVENESS OF INITIATORS: PART I: INTRODUCTION AND THE STUDY OF SPARK CHARACTERISTICS, by F. W. J. Moore, J. F. Sumner and R. M. H. Wyatt. March 1956. ERDE report no. 4/R/56. Unclassified report.

A review of the literature on spark ignition of initiatory explosives has shown the necessity for a detailed study of condenser spark discharges and how their characteristics and energy dissipation are affected by altering circuit resistances, inductances and gap widths.

It is shown that the inclusion of a spark gap in a condenser circuit introduces essentially a source of variable resistance, and the general features of condenser discharge are unaltered-e.g., as the value of the circuit resistance is increased the discharge changes from an oscillatory one to a unidirectional one and the time of discharge decreases and then increases; correspondingly, the energy dissipated in the spark falls from approximately 100 per cent of the stored energy to about 10 per cent and remains at that level as the unidirectional sparks are lengthened.

99 Explosives Research & Development Establishment. Great Britain.
THE NON-EXISTENCE OF LEAD STANNATE, by R. J. Face and R. L. Willians. July 1957. E. R. D. E. 6/R/57. Unclassified report.

The infra-red spectra of sodium stannate, lead stannate, and a number of related compounds have been measured. The spectrum of the sodium salt is consistent with the structure $Na_2(Sn(OH)_6)$. Lead stannate on the other hand shows a spectrum identical with mixtures of hydrated stannic oxide and various basic lead salts.

100 Feitknecht, W. and M. Sahli.
"Knowledge of the basic azides: I. The Basic Lead azides." In HELV. CHIM. ACTA. v. 37: 1954. pp. 1423-1431. Translated and issued by Technical Information Bureau for Chief Scientist, Ministry of Supply, Great Britain; June 1955. TIB/T4469. Unclassified report.

Three new methods of preparing basic lead azides are described: 1. hydrolysis of lead azide with water; 2. conversion of lead azide with alkali; 3. precipitation of lead salt solution with a mixture of sodium azide and sodium hydroxide. The different methods also supply, in some cases, different basic azides.

Nine different basic azides (lead) could be identified by x-ray diffraction. Their Pb and N_3 content was determined analytically and the O and H_2O content determined from the residue. With 8 of the 9 forms, the computed water content is so low that the presence of oxy-or possibly oxyhydroxyazide must be assumed only one of the compounds should be a hydroxyazide. (ama).

101 Feltman Research and Engineering Laboratories. Picatinny Arsenal.
DEVELOPMENT OF AN IGNITION TRAIN FOR USE IN THE T34E2 NONMETALLIC FRACTICE MINE, by Richard W. Snook and Robert L. Wagner. April 1957. High Explosives Section Report No. [illegible]. Ord project no. TA3-5020 an. Unclassified report.

An investigation to improve the reliability of the ignition train of the T34E2 nonmetallic antipersonnel mine is described in detail. The unreliable delay mixture previously used -- black powder/gum yacca -- was replaced with a new mix designated DF-418 and consisting of 54.31 15 barium chromate (Spec JAN-B-550)/zirconium nickel alloy, powdered, Type I (Spec MIL-Z-11410A)/potassium perchlorate (Spec JAN-P-217). A simpler primer mix to replace the original 8-ingredient mix was sought and a special M31 mix (potassium chlorate, lead thiocyanate) was extensively investigated. Duds persisted, nowever, and no completely satisfactory primer was developed. Use of gilding metal cups and closing discs were tried to avoid the undesirable effects on the charge of the flexibility of plastic components. (reh)

102 Feltman Research and Engineering Laboratories. Picatinny Arsenal.
PRELIMINARY STUDY OF SEALANTS FOR STAINLESS STEEL DETONATORS, by K. G. Sheffield. May 1958. Explosives Development Section report no. 22. Ordnance Project no. TA3-5101. Unclassified report.

The use of stainless steel instead of gilding metal for detonator cups is desirable. Eliminates the need for a protective coating on the inner walls of cups loaded with lead azide. It also makes thinner-walled cups practicable, leaving more space inside the cup for the explosive. Tests were conducted to determine and compare the storage stability of stainless steel and gilding metal cups sealed with lacquer, enamel, alkyd resin, and epoxy alkyd resin. After one month at 160°F and 95% R.H., gilding metal cups sealed with lacquer, enamel or alkyd resin functioned 100% high order, and cups sealed with epoxy alkyd resin functioned 14% high order. Stainless steel cups functioned 89% high order when sealed with lacquer, 78% with enamel, 52% with alkyd resin, and 50% with epoxy alkyd resin. After cyclic storage (-65°F to 160°F/95% R.H.), both cup materials showed similar functioning patterns, except that markedly poorer results were obtained with gilding metal plus lacquer. The author recommended further tests to determine the effect of cleaning and roughening the stainless steel before applying the sealant. (reh).

103 Feltman Research & Engineering Laboratories.
SPEECHES PREPARED BY PAUL B. TWEED AND DONALD E. SEEGER FOR THE SYMPOSIUM ON MICROMINIATURIZATION OF ELECTRONIC ASSEMBLIES. 30 September - 1 October 1958. Explosives Development Section report no. 37. Held at Diamond Ordnance Fuze Laboratories. Unclassified report.

Part 1: Explosive trains for miniature electric initiators: There appear to be numerous methods of reducing the number of explosive charges in initiators and there are devices available which will transmit detonation in very small diameters. Combinations of these devices and emphasis on development of smaller initiators should certainly lead to miniature and even microminiature explosive trains.

Part 2: Development of miniature electric detonators: Work has not progressed rapidly because definite requirements,

which are now essential before development of a specific initiator can be started, were lacking. Two such detonators, under development, are the T29 and T48 both of which are initiated directly by either electrical or mechanical energy. (ama)

104 Feltman Research and Engineering Laboratories. Picatinny Arsenal.

POLAROGRAPHIC ANALYSIS OF PRIMER MIXTURE FOR M60 BASE-DETONATING FUZE, by Charles Ribaudo and Delbert Cragle. October 1958. PA technical report 2549. ORD project AR-AF-15. Unclassified report.

Polarographic methods for the determination of TNT and the simultaneous determination of antimony trisulfide and lead thiocyanate. Standard deviations are 0.05%, 1.03% and 0.11%, respectively. The time required for the three determinations is 1.5 hours.

The accuracy and reproducibility of these methods are superior to existing methods of analysis. The amount of sample required for analysis is a fraction of that required by methods described in Specification MIL-F-20414. (vis)

105 Feltman Research and Engineering Laboratories. Picatinny Arsenal.

ENERGY DETERMINATION OF CARBON BRIDGE DETONATORS, by Julius Silverstein. October 29, 1958. Pyrotechnic Laboratory technical note no. PL-R 13. Unclassified report.

A method of evaluating the energy delivered to the carbon bridge of a pyroswitch initiator from a cold cathode diode. Because the resistance of the bridge varies with time during burning, it was necessary to use two oscilloscopes, one to record current and the other to record voltage, and to photograph the two oscilloscope images separately. The two curves obtained (one for voltage and the other for current) were then multiplied and integrated to get the energy dissipated. A polar planimeter was used to integrate the power-time curves. (reh)

106 Feltman Research and Engineering Laboratories. Picatinny Arsenal.

INFLUENCE OF FLASH HOLE DIAMETER ON PERCUSSION PRIMER FUNCTIONING CHARACTERISTICS, by R. L. Wagner and E. L. Miller. February 1959. Explosives Development Section report no. 52. Unclassified report.

An evaluation of the output characteristics of no. 68 type percussion primers having flash hole diameters of .125", .093" and .070". Data on time to initiation, impulse of explosion, length of flame, duration of flame and flame temperature are tabulated. Results show that primers with a flash hole of .093" has a higher output than those with flash holes of .125" or .070". (vis)

107 Feltman Research and Engineering Laboratories. Picatinny Arsenal.

EVALUATION OF A NO. 6 TYPE ELECTRIC PLASTIC BLASTING CAP DEVELOPED BY OLIN MATHIESON CHEMICAL CORPORATION, by F. K. Van Arsdale. March 1959. Explosives Development Section report 55. ORD project TA3-5306. Unclassified report.

The No. 6 electric blasting cap consists of a 98 mg mercury fulminate-nitrocellulose ignition charge, a 288 mg dextrinated lead azide intermediate charge and a 325 mg RDX base charge. Firing test results are considered satisfactory. No cap fired with 0.2 ampere and all caps functioned with 0.45 ampere of electrical energy. Functioning times ranged from 27.4 to 71.8 milliseconds.

From a military standpoint, the explosive loading of the No. 6 cap would have to be modified as mercury fulminate is not acceptable due to its instability and poor storage characteristics. (vis)

108 Feltman Research and Engineering Laboratories. Picatinny Arsenal.

INVESTIGATION OF BRITISH SERVICE LEAD AZIDE, by R. L. Wagner, E. G. Sheffield, and D. E. Seeger. April 1959. Explosives Development Section report no. 57. TNI-2707 Ag. Unclassified report.

A comparison of the physical, chemical, and explosive properties of British Service lead azide and dextrinated lead azide. Data shows that British Service azide is more sensitive to impact, is less hygroscopic and has an energy output which is 2.5 times higher than dextrinated lead azide.

Although British Service azide is superior to dextrinated azide it does not have any substantial advantages over RD-1333 and IVA azides. (vis)

109 Feltman Research and Engineering Laboratories. Picatinny Arsenal.
DEVELOPMENT OF T6 ELECTRIC AND T7 NONELECTRIC BLASTING CAPS (U), by F. K. Van Arsdale. April 1959. FA technical report 260e. Army project 5A07-02-001. ORD project TS1-400. Confidential report.

The blasting caps dealt with in this report were developed because standard designs failed to function properly after exposure to tropical or moist climates. Special protection against moisture is provided, in the nonelectric (T7) design, by a flaring rim at the end which connects into the demolition device. The electric cap (T6) has its insulated copper lead wires embedded in a cast sulphur plug, over which the rim of the loaded cup is crimped. A special sealing compound is then injected into the crimped joint. Both designs functioned satisfactorily after thorough environmental testing. (reh)

110 Feltman Research and Engineering Laboratories. Picatinny Arsenal.
INVESTIGATION OF POLYVINYL ALCOHOL LEAD AZIDE FOR USE IN DETONATORS, by R. L. Wagner, K. G. Sheffield, and D. E. Seeger. May 1959. Explosives Development Section report no. 60. Unclassified report.

A comparison of physical, chemical, and explosive properties of polyvinylalcohol (PVA) lead azide and dextrinated lead azide. Results show that PVA azide is 4 times less hygroscopic. There is no significant difference in impact sensitivity and 120°C vacuum stability.

Functioning characteristics of M47 detonators have been determined. The efficiency of M47 detonators loaded with PVA azide is 2.5 times greater than detonators charged with dextrinated azide. Detonators loaded with PVA azide functioned normally whereas low order functioning occurs in dextrinated azide detonators.

It is recommended that the intermediate charge of dextrinated lead azide in the M47 detonator be replaced with PVA lead azide.

111 Feltman Research and Engineering Laboratories. Picatinny Arsenal.
DELAY DETONATOR FOR 30 mm AMMUNITION, by E. L. Miller. May 1959. Explosives Development Section report no. 61. Unclassified report.

NOL development of a delay detonator for 30 mm ammunition is described. First tests conducted with a design similar to the Navy MK 10 delay detonator revealed two faults - 36% of the items tested fired low order; 12% of the items tested had long delays. Broadening the explosive column by reducing the wall-thickness of the detonator cup cured these two faults, but led to too many super-quick functionings caused by collapse of the thin detonator cup walls. Use of steel cups with slightly thicker walls was considered and remains to be investigated. (reh).

112 Feltman Research and Engineering Laboratories. Picatinny Arsenal.
INVESTIGATION OF M61 PERCUSSION PRIMERS AND THE DRI PERCUSSION PRIMER TEST EQUIPMENT, by E. L. Miller and M. T. Hedges. May 1959. Explosives Development Section report no. 62. Unclassified report.

To evaluate both primer and test equipment, one hundred M61 primers were tested on the Denver Research Institute percussion primer equipment (Model XMC-72-1, developed under Army contract no. DAI-23-072-501-ORD-(P)-14). This equipment tests for hangfire in terms of time from application of energy to a firing pin solenoid till a visible flame appears; for flame duration in terms of time from first visible flame to time when flame dies down to a pre-determined level; explosion force in terms of effect of shock on a crystal transducer; flame temperatures in terms of a filtered wave length of light characteristic of the type of primer tested; and flame length in terms of distance a predetermined flame intensity reaches.

Correlation of DRI equipment results with ball-drop test results was attempted, and effect of varying pin settings in the DRI apparatus investigated. The M61 primer failed the functioning test. The information obtained with the DRI apparatus was found a better criteria for acceptance than that obtained with the ball-drop test. Standards for evaluating M61 primers with the DRI apparatus were worked out. (reh)

113 Feltman Research and Engineering Laboratories. Picatinny Arsenal.

INVESTIGATION OF M61 PERCUSSION PRIMERS AND THE DRI PERCUSSION PRIMER TEST EQUIPMENT, by E. L. Miller and M. T. Hedges. June 1959. Explosives Development Section report no. 67. Unclassified report.

A continuation of work covered by E.D.S. report no. 62 (same title) additional lots of M61 primers - each lot being one day's production - were tested on the DRI apparatus. These primers contained a styphnate-type mixture, whereas the primers formerly tested contained chlorate type mixtures. Test results indicated that firing pin point contour and firing pin impact velocity have a marked effect on the functioning characteristics of the M61 primers. In tests at 350 volts, 100% failures resulted from use of one firing pin contour, whereas another pin contour gave 100% firings at the same voltage. A difference in functioning characteristics was found to exist between styphnate-type and chlorate-type primers. (reh).

114 Feltman Research and Engineering Laboratories. Picatinny Arsenal.

A STATISTICAL EVALUATION OF THE PYROTECHNICS ELECTROSTATIC SENSITIVITY TESTER, by Everett Crane, Chester Smith, and Alonzo Bulfinch. July 1959. TA technical note no. 26. Army project 5B4-01-027, ORD project TB5-5437. Unclassified report.

An electrostatic sensitivity tester developed at Picatinny Arsenal was evaluated statistically. The factors found to contribute most significantly to optimum instrument operating conditions were resistance, humidity, energy, and the relationship of energy to resistance. The electrostatic sensitivity results obtained with fine magnesium powder specimens were found to to be reproducible. It was concluded on a variety of samples to determine the effect of various characteristics of the circuit and the maximum energy input which will produce no burning in a specified number of trials. A method for measuring this can be developed by studying the lower tails of the spark sensitivity curves. Deviations in the lower tails of the curves, which are unique for each material, are the best indicators of the materials' sensitivity characteristics.

115 Feltman Research and Engineering Laboratories. Picatinny Arsenal.

INVESTIGATION OF IGNITER, ELECTRIC, T42E1; by E. L. Miller and C. A. Bandstra. August 1959. Explosive Application Section report no. 75. Unclassified report.

To determine whether the T24E1 electric igniter was suitable for use with British ammunition fired from the 120mm T123 gun, 500 igniters were subjected to a run-down test, a Bruceton Staircase sensitivity test, a constant-current test (at 0.44 ampere for 5 minutes), and an increased current functioning test. The resistance of these items was to be between 0.8 and 1.8 ohms. Detailed test results are given and discussed especially in terms of the significance of the no-fire point. (reh)

116 Feltman Research and Engineering Laboratories. Picatinny Arsenal.

EVALUATION OF A CONDUCTIVE MIX MODIFIED T77 ELECTRIC DETONATOR, (U), by R. J. Heredia. September 1959. Explosives Application Section report no. 76. Unclassified report.

To reduce the cost of the T77 electric detonator, work was done by a contractor (Beckman Instruments, Inc., Army contract no. DA-28-017-501-ORD-3090) to develop a conductive mix version of the T77. Requirements for this modified version were: have same external dimensions and contour as to original T77; be fired reliably by 1.5 volts D.C. at less than 1 amp. applied for 100 microseconds; initiate an RDX booster pellet across a .015-inch air gap and through a 0.010-inch brass barrier. The detonators developed were loaded with a 144 mg. RDX base charge, a 80 mg PVA lead azide intermediate charge, and a conductive mix consisting of 10 mg of 75/25 PVA lead azide/Hanova silver. Shawinigan black was first tried as the conductive additive but its resistance was too high. 500 detonators were manufactured and tested at Franklin Institute. Results indicated further work would be needed. Such work was not performed for lack of funds. (reh)

117 Feltman Research & Engineering Laboratories.
T2 WEATHERPROOF BLASTING FUSE IGNITER, by J. F. Noonan. October 1959. Notes on development type material no. 209. ORD project no. TSI-400. Army project no. 5A07-02-001. Unclassified report.

Describes the construction, characteristics, use, handling, and storage of the T2 fuse igniter. This device, designed to reliably ignite the M700 time blasting fuse in air or under water, is intended to replace or supplement the M2 fuse lighter, which lacks sufficient holding power to consistently retain the fuse in the igniter when fired and which is not properly sealed for underwater use. Tests have demonstrated that the T2 igniter will initiate the M700 fuse after being submerged in 30 in of water for as long as 6 hrs.

Improvements over the M2 include venting between the firing chamber, the upper body, and the atmosphere; and the prevention of accidental firing by maintaining the firing pin spring under no load until the item is in actual use. (ama)

118 Feltman Research and Engineering Laboratories. Picatinny Arsenal.
DEVELOPMENT OF UNIVERSAL HIGH-ALTITUDE, HIGH-TEMPERATURE-RESISTANT SQUIBS WITH AND WITHOUT RF AND MF PROTECTION, by Charles Knipp. October 1959. PA technical report 2653. PB 142488. Unclassified report.

Prototypes of universal high-altitude, high-temperature-resistant squibs both with and without RF and microwave frequency (MF) protection, have been developed. They are designed to endure such outer space conditions as temperatures of 200°C; vacuums of 10^{-8} mm mercury; and the vibration, acceleration, and shock of rocket launching and flight

Experimental pyrotechnic compositions which function at less than 1.5 amperes and 20-micron pressure when tested in the M1A1 electric squib housing have been formulated. In closed-bomb tests, these compositions have produced pressures of 1500 psi. Ignition temperature tests have shown them to be safe at well above 300°C.

By completely encapsulating the squib proper and the hot lead wire, a marked reduction in RF and MF sensitivity is achieved which, it is believed, will protect the squib against radiation ranging from 50 mc/sec to 150 kmc/sec.

Special ultra-high-vacuum testing equipment developed to test the new squibs consists of a stainless steel manifold with a number of ports to which test chambers are attached, and a vacuum pump capable of continuous operation for a number of years at 10^{-8} to 10^{-10}mm mercury.

Outstanding features of the new squibs are the hermetic sealing of the charge compartment and the use of materials of very low vapor pressures-stainless steel, Kovar, and glass or ceramics.

119 Feltman Research and Engineering Laboratories. Picatinny Arsenal.
A RELIABLE INSENSITIVE ELECTRIC DETONATOR, by J. V. R. Kaufman. November 1959. PA technical report 2658. Army project 5A04-10-006. ORD project TB3-0115B- Item F. Unclassified report.

Describes the preparation of an insensitive electric detonator having the desired attribute of excellent reproducibility. A pure-gold exploding wire is used to initiate a loosely packed charge of controlled-particle-size PETN. Reaction times of 5-microseconds have been obtained with this item. (mw).

120 Feltman Research & Engineering Laboratories. Picatinny Arsenal.
LEAD AZIDES FOR USE IN DETONATORS, by R. L. Wagner. January 1960. PA technical report no. 2662. ORD project no. TN1-2707 AG. Army project 505-01-003. Unclassified report.

During the development of a short detonator (M47) for use in 20 mm ammunition it became evident that as smaller fuzes were made, more efficient explosives for use in initiators would be needed. To meet such a need several different types of lead azide were investigated as possible replacements for the standard dextrinated lead azide covered by Military Specification MIL-L-3055. The types of lead azides investigated include dextrinated, RD-1333, polyvinyl alcohol (PVA), British Service, colloidal, and dextrinated colloidal.

A minimum of 25 mg RD-1333 lead azide or 30 mg PVA lead azide was required to initiate RDX in the M47 detonator as compared with 90 mg for dextrinated lead azide. Neither

RD-1333 nor PVA was hygroscopic, but dextrinated lead azide picked up over .5% moisture in 35 minutes at 82%-92% relative humidity. RD-1333, PVA, British Service, colloidal, and dextrinated colloidal lead azide had impact sensitivities of 5, 4-5, 2, 2, and 3 inches, respectively, using the 2-kg weight, as compared with 4-6 inches for dextrinated lead azide.

121 Feltman Research and Engineering Laboratories.

ENERGY MEASUREMENTS IN THE EXPLOSION OF PRIMERS, by W. Neddack and E. Grosch. March 1960. Picatinny Arsenal translation no. 72. Translated by U. S. Joint Publications Service from Zietschrift Fur Elektrochemie, 57:632-6 (1953).

Pressures produced by the detonation of various primer explosives in a lead-lined, nitrogen-filled closed bomb were measured and recorded with a piezoelectric sensing element (built into the bomb), an amplifier, and a cathode-ray tube. The explosives used were silver azide, lead azide, mercury azide, and mercury fulminate. The pressure diagrams obtained differed depending on the kind and quantity of explosive, the packing and whether the material was lumpy or finely crystallized. (reh).

122 Feltman Research and Engineering Laboratories.

DEVELOPMENT OF EXPLODING BRIDGEWIRE INITIATORS, by Maurice T. Hedges. Presented at the Seventh Meeting of the Production Subcommittee to the Integration Committee on Ammunition Loading, Duke University, 27-28 April, 1960. Artillery Ammunition and Rocket Development Laboratory report no. 84. Unclassified report.

Two exploding bridgewire (EBW) detonators were designed and work on two EBW primers was begun at Picatinny. Simplicity and safety are the principal advantages of this type of detonator. Since the explosion of the bridgewire provides the shock needed to initiate the main detonator charge directly, no primary explosive is needed in the powder train. Because high voltages (1500-3000 volts) are needed to initiate EBW detonators, they are very safe. One of the two detonators developed at Picatinny will not fire when tested for sensitivity to static electricity, nor when plugged into a 110 volt circuit. Loads of 2 and 4 amps also failed to fire it. Both detonators are reliably fired by the discharge of a 1-microfarad capacitor charged to 1500 volts. The theory and operation of the EBW-type initiator are fully explained, and several methods of adapting it to the initiation of propellants are described. (reh).

123 Ferrara, F. B.

ENERGIZER ASSEMBLY. March 25, 1958. United States. Patent no. 2, 827, 851.

Describes a possible method for actuating an electromechanical transducer in order to produce, across the transducer, an electric potential difference. An explosive primer assembled with an electromechanical transducer in the manner which is described, will produce a stress across the transducer when it is detonated. This stress will consistently produce a required voltage. The voltage produced will in turn, depend upon the quantity of primer used. (vis)

124 Filbert, W. F.

NEW COMPOSITIONS OF MATTER. April 26, 1938. U. S. Patent no. 2, 115, 066.

An ignition composition in an electric blasting initiator comprising a basic heavy metallic salt derivative of alpha-trinitrophenyl-nitramino-isobutyric acid.

125 Fleischer, Joseph and J. G. Burtle.

INITIATING EXPLOSIVES. June 10, 1947. United States. Patent no. 2, 421, 778.

Describes a process for the preparation of lead azide in the presence of polyvinyl alcohol or other soluble organic polymers. The material so prepared is crystalline, has an average apparent density of 1.23 g/cc., and functions efficiently as an initiator of high explosives.

This process yields a product which is substantially free from both course and fine particles and one having improved handling and pressing characteristics. (mw)

126 Frankford Arsenal.

FRANKFORD ARSENAL PRIMER MIXTURE NO. 88. February 13, 1918. File no. 471/83.9.5. Unclassified report.

Describes the manufacture of the subject primer mix. Data is reported for the following tests: velocity pressure and accuracy test on .30 cal and .45 cal ammunition; stability test. The results of these tests indicate good stability and satisfactory ballistic character.

The chemical difference between this primer and the Winchester mix are: (1) substitution of 3% tetryl for 5% TNT; (2) addition of 2% of litharge. Mixture was recommended for adoption in cal. .30 and cal. .45 ammunition. (ama)

127 Frankford Arsenal.

THE EFFECT OF CHANGES IN MASS OF THE FALLING BALL ON THE SENSITIVITY OF PRIMERS, by C. W. Churchman. Primer Information Committee bulletin no. . Unclassified report.

A mathematical method is presented for predicting the behavior of primers in weapons, on the basis of the results of drop tests in which the effective mass of the striker is known. It is pointed out that the sensitivity of primers is not exactly proportional to the mass of the ball used in a drop test (that is, a lot which functions 100% when impacted at 8 inches by a 4-oz ball will not necessarily function 100% when impacted at 8 inches by an 8-oz. ball). Presented are the results of experiments conducted at Frankford Arsenal in which the formula $\bar{H} = H_o + B/m$ where $\bar{H}$ is the 50% firing height, m is the mass of the weight dropped and H_o and B are constants. (rh)

128 Frankford Arsenal.

ABNORMAL FLATTENING OF PRIMERS, by Rechel. Primer Information Bulletin no. 8.

Abnormal flattening of .30, .45 and .50 caliber primers occurs when high insertion forces are applied during the insertion process. Damage to the pellet and cup with accompanied loss of sensitivity is the usual result. This problem can be eliminated by a modification in the cleaning process used to prepare the cartridge cases for primer insertion.

The cartridge case, after pickling, is immersed in a soap solution for 5 minutes. This deposits a thin soap film on the cartridge surface which acts as a lubricant and reduces the insertion forces necessary, thereby permitting the primer to be seated without undue flattening. (wa)

129 Frankford Arsenal.

SMALL ARMS PRIMERS, by E. R. Rechel. March 1932. FA report no. 10. Unclassified report.

Developments described include: noncorrosive mixtures to replace the standard FA 70 mixture which yields corrosive hydrochloric acid on firing; and modification of the then-standard mercury fulminate composition to reduce its hangfire rate. Compositions investigated included a number of non-corrosive non-fulminate materials. Wet vs dry mixtures were compared. Results of sensitivity tests and hangfire tests have been described in detail for 59 mercuric non-corrosive priming mixtures, 23 chlorate mixtures, and 10 non-mercuric, non-corrosive mixtures.

Theoretical discussions are presented on the mechanisms of percussion ignition, and the significance of such factors as granulation, coefficient of friction, ignition temperature, and characteristics of the primer flame.

130 Frankford Arsenal.

MANUAL FOR SMALL ARMS PRIMER SENSITIVITY TESTS. n.d. FA report no. R259. Unclassified report.

Specific drop test procedures of Cal. 30, Cal. 30 Carbine, Cal. 45 and Cal. 50 ammunition primers are described, and a method for calculating H and s is explained. (reh)

131 Frankford Arsenal.

THEORY AND APPLICATION OF SENSITIVITY CURVES OF SMALL ARMS PRIMERS AS DETERMINED BY THE STANDARD DROP TEST MACHINE, by C. W. Churchman. December 1942. FA report no. R-259. First report on research item no. 207.11. Unclassified report.

The then-standard method for drop-testing small arms is described and a new drop-test method is proposed. Under the new method, testing is conducted at intermediate heights where some primers fire and some do not instead of at the extreme no-fire height. Sampling techniques are discussed, the Taylor-Weale hypothesis is analyzed and criticized, and a proposed standard acceptance test for primers is described. (reh)

132 Frankford Arsenal.

MANUAL FOR PROFOSED ACCEPTANCE TEST FOR SENSITIVITY OF PERCUSSION PRIMERS, by C. W. Churchman. January 1943. FA report no. R-259A. Second report on research item no. 207.11. Unclassified report.

The run-down method for testing primers for sensitivity is described in detail in non-technical language, together with the derivation and significance of the "normal probability function" Acceptance is based on the normality of the distribution of fires and misfires over a range running from the no-fire drop height to the all-fire drop height. Preparation and maintenance of quality control charts based on this method is described. (reh)

133 Frankford Arsenal.

ANVIL CONTOUR AND RADIUS POINT, by E. M. Arnold. 13 December 1943. Primer information bulletin no. 16. Unclassified report.

Presents a summary of data received by the committee from various facilities on anvil point radius, or anvil contour. (ama)

134 Frankford Arsenal.

ON A METHOD OF DETERMINING SIGNIFICANT DIFFERENCES IN PRIMER SENSITIVITY, by C. W. Churchman. (1944) Primer Information Bulletin no. 21. Unclassified report.

A statistical method is presented for determining whether a proposed small change in the structure of a primer will, in the long run, increase or decrease the primers' sensitivity. Also given is a method of setting quality control limits on primer sensitivity in a manner more sensitive than that given in previous reports. (rh)

135 Frankford Arsenal.

LEAD THIOCYANATE - EXPERIMENTAL WORK CARRIED OUT AT UTAH ORDNANCE PLANT, by E. M. Arnold. 3 March 1944. Primer information bulletin no. 23. Unclassified report.

The results of research carried out at the Utah Ordnance Plant on lead thiocyanate processed from the ammonium, potassium, and sodium thiocyanate salts. Describes the analytical procedure used to assay ammonium, sodium and potassium thiocyanates. Such data as apparent density, percentage composition, purity and percent alkali metal impurities are listed. Also given are: photomicrographs showing the difference in particle size and shape; average height of fire to obtain firing. (ama)

136 Frankford Arsenal.

M29 PRIMER SENSITIVITY, by Stevens. September 1944. Primer Information Bulletin no. 35. Unclassified report.

Summarizes the results of a series of comparative tests undertaken at Frankford Arsenal to determine the effect of various factors on the sensitivity of M29 primers. These factors include anvil height, anvil contour, regular and sharp point anvils, metal components, and storage testing.

It was concluded from this data that: (1) Primers assembled flush are more sensitive than primers assembled with anvil protusion. (2) Primers tested in a threaded unit give a higher sensitivity than primers tested loose. (3) Primers with a mean anvil height 0.088" were the most sensitive of the three anvil heights tested.

A storage test of M29 primers at 98% relative humidity, 40°C, at various concentrations of ammonia vapor was conducted. Results indicate that a severe and rapid decomposition of the primer mixture occurred with resultant loss in sensitivity of the primers. All concentrations tested were found to affect the sensitivity. (ama).

137 Frankford Arsenal.

EFFECT OF DRY COMPRESSION ON PRIMER SENSITIVITY, by C. W. Churchman. February 1945. Primer information bulletin no. 36. Unclassified report.

Describes a preliminary investigation on cal. .50 primer sensitivity. The data presented is indicative and substantiates the claim that dry compression is responsible for increased sensitivity. It is shown that as the degree of compression (as measured by the thickness of the disc used) increases, both the average height and standard deviation decrease. (ama)

138 Frankford Arsenal.

OPERATING TIME MEASUREMENTS OF ELECTRIC (BRIDGE-WIRE TYPE) DETONATORS AND SIMILAR IGNITERS, by J. R. Vigliante. July 1945. Report no. R-638. Unclassified report.

A thyratron tube method of testing electric detonators is described. In addition to operating time and energy input, it provides information on the duration of current flow through the detonator, the fusing point of the bridgewire, and the delay time of the detonator. Tests of the T3 and T3E1 detonators, the duPont "SSS" and Atlas No. 8 blasting caps, and "Bazooka" rocket primers were conducted by the new method at currents ranging from 125 milliamperes to 25 amperes and operating times ranging from 14.0 to 15,000 microseconds. Of the items tested, the T3 and T3E1 detonators were fastest. Inductance coil tried as a safety device but found to increase fuze functioning time quite appreciably. (rev)

139 Frankford Arsenal.

CALIBER .50 ELECTRIC PRIMERS, GERMAN 20 MM DESIGN, by J. W. Mitchell. December 1945. FA report no. R-675. First report on project no. 3-2895. Unclassified report.

Twenty thousand electric primers patterned after the German 20 mm electric primer but scaled down to fit the cal. .50 case pocket have been manufactured. Components were fabricated under contract with the General Electric Co., Glass Machine Division and were assembled and loaded by the Military Explosives Division of E. I. duPont deNemours Co. Details of the contract negotiations with these firms, materials used, and manufacturing procedures are given.

Complete ballistic tests were not conducted because of the faulty functioning of the primers which rendered them unsatisfactory for the intended purpose in [illegible] ammunition. The data obtained enable establishment of the following characteristics of the primers:

(a) Good functioning time of 0.15-0.20 ms.
(b) Insufficient charge of priming composition resulting in poor powder ignition unless a black powder booster charge is used.
(c) High and variable electrical resistance in 20-30% of the primers and a tendency for a considerable percentage of the remainder to develop high resistance in handling.

This type of electric primer is not believed to be suited to large scale production on automatic machinery.

140 Frankford Arsenal.

STUDY OF PRIMER PACK ARRANGEMENTS, by W. F. Weis. 30 June 1950. Report no. R-978. Project no. 27 E6, second report. Unclassified report.

The objectives of the study were accomplished with the packaging of all types of primers for small arms ammunition in three sizes of cartons, as appropriate, within hermetically tight ammunition cans and boxes. All of the 15 pack arrangements studied are efficiently contained, although four of the group were judged unsatisfactory. These four packs are considered to contain too large a quantity of primers and too high a concentration of primer composition and thereby constitute potential safety hazards during transportation and storage. The eleven packs considered satisfactory embrace all of the primer types and so permit a selection of those packs having the best application. All of the packs developed were considered as individual unit packs and evaluated accordingly, but they are intended, of course, to be packed two or more together in the usual manner in the appropriate shipping box.

141 Frankford Arsenal.
AUTOMATIC RESISTANCE TESTER, ELECTRIC PRIMER, M52A3, by R. S. Zelenka. December 1953. FA report no. R-1174. ORD project TS1-47. Unclassified report.

A resistance tester for the inspection of the M52A3 type electric primer has been developed which automatically checks loose or cased primers for both high and low resistance limits at one station. The instrument was used for several months in the Small Arms Ammunition Department, Frankford Arsenal, testing primed cases, and on the basis of these tests was accepted as the Ordnance standard (Drawing D7553513) for the inspection of M52A3 electric primers.

142 Frankford Arsenal.
PRIMER, PYROTECHNIC, AND INCENDIARY COMPOSITIONS FOR SMALL ARMS AMMUNITION. October 1954. Manual no. P-1, revision no. 2. Unclassified report.

Prescribes the methods used for the manufacture of primer and pyrotechnic compositions for use of the Army. Gives minimum safe standards for insuring the continuity of production and for safeguarding personnel and property. (ma)

143 Frankford Arsenal.
STANDARDIZATION OF LEAD STYPHNATE PRIMERS, PRIMING MIXTURES AND PROCESSES. SECOND REPORT: IN-PROCESS HANDLING SYSTEM, by R. E. Donnard. May 1958. FA report no. 1444. CAC project no. 5P020-1. Unclassified report.

A conductive tray which will hold 510 lead styphnate primers has been designed and tested. Primers are held in a fixed position in small cavities within the tray by an aluminum sleeve that encases the tray. Experiments indicate that when the primers are placed anvil face down in the cavities which have a depth of 0.132-0.002 inches and a diameter of 0.223 ± 0.004 inches, mass detonation is eliminated. The subject trays have markedly reduced the possibility of accidental explosion in storage or handling and also have eliminated certain hazardous hand operations. (vis)

144 Frankford Arsenal.
CARTRIDGE, CALIBER 30, MATCH, T291 ASSEMBLED WITH FRANKFORD ARSENAL NO. 36 PRIMER, by A. F. Schlack and R. E. Donnard. June 1958. Memorandum Report No. 104. Unclassified report.

The accuracy of cartridges, caliber .30, Match, T291 primed with Frankford Arsenal No. 36 primer was not significantly different from the accuracy of this ammunition primed with the control primer. There was a slight improvement in accuracy when cartridge, caliber .30, Match, T291, was primed with the Frankford Arsenal No. 36 primer. There was a 40.6% improvement in dispersion of average velocity, by the use of the Frankford Arsenal No. 36 primer. The indoor accuracy at 300 yards of cartridge, caliber .30, Match, T291, primed with the Frankford Arsenal 36 primer, was not significantly different from the accuracy of this ammunition primed with the control primer. There was a 11.8% decrease in mean radius for outdoor accuracy at 600 yards for cartridges, caliber .30, Match, T291 when the Frankford Arsenal No. 36 primer was used. The velocity and pressure results were similar regardless of the primer employed in this ammunition.

145 Frankford Arsenal.
EVALUATION OF EFFECT OF VARIOUS PELLET WEIGHTS OF M52A3 AND M52A4 PRIMERS ON BALLISTIC PERFORMANCE OF CARTRIDGE, 20MM, BALL, M55; by Bernard Schein. February 1959. FA report no. R-1456. Project TS1-47. Unclassified report.

An evaluation was made of the effect of various pellet weights of Primers, M52A3 (lead styphnate), and M52A4 (Zirconium), on ballistic performance of Cartridge, 20mm, Ball, M55, loaded with IMR 7005 or X1034 propellant at various temperatures and with and without vent seals.

A primer characteristics measuring device manufactured by Denver Research Institute was evaluated to determine if the primer characteristics measured by the device could be correlated with measured ballistic results.

146 Frankford Arsenal. Research and Development Group.
DEVELOPMENT OF A CARTRIDGE ACTUATED DEVICE INITIATOR, T28, by W. E. Chandler. February 1959. FA technical report no. R-1508. Army project no. 502-06-001, ORD project no. TS1-15. Unclassified report.

The T28 initiator is a single shot cartridge-actuated device with the same performance characteristics as the M3 initiator. The T28 initiator has an integral gas-actuated exactor capable of being actuated by an M3 initiator through 15 feet of flexible hose (MS28741-4). The exactor can be actuated manually in case of a system failure.

147 Frankford Arsenal.

STANDARDIZATION OF LEAD STYPHNATE PRIMERS, PRIMING MIXTURES AND PROCESSES. FIRST REPORT: THERMOCHEMICAL PROPERTIES OF VARIOUS PRIMING MIXTURES, by A. F. Schlack and R. E. Donnard. April 1959. FA report no. R-1490. OAC project no. 56-155. Unclassified report.

This report evaluates a primer output resulting from several possible changes of primer composition. This evaluation is achieved by an examination of the trend of the thermochemical properties of the primer.

Four thermochemical properties such as oxygen deficiency, number of moles of product gases, heat evolved and the adiabatic flame temperature are considered, discussed, and evaluated showing their trend as the primer mixtures are varied in percentage of their composition.

148 Frankford Arsenal.

STANDARDIZATION OF LEAD STYPHNATE PRIMERS, PRIMING MIXTURES AND PROCESSES. THIRD REPORT: DETERMINATION OF PERCENT NORMAL LEAD STYPHNATE FOR PRIMING MIXTURE, by A. F. Schlack and R. E. Donnard. May 1959. FA report no. R-1491. OAC project no. 56-155. Unclassified report.

This report describes the study made to determine the best percentage composition of normal lead styphnate in relation to other ingredients proposed for the standard noncorrosive priming mixture for caliber .30 ammunition

It was concluded that the most satisfactory percentage of normal lead styphnate is approximately 35%.

149 Frankford Arsenal.

DEVELOPMENT OF AN ELECTRIC PRIMER (FAT3-E7) COMPATIBLE WITH SINGLE BASE, EXTRUDED COOL BURNING PROPELLANT, by R. E. Donnard, A. F. Schlack and S. C. Piccoli. June 1959. FA report no. R-1477. Army project no. 504-05-029. ORD project no. TS1-47. Unclassified report.

Describes electric primers which have greater thermal outputs than the thermal output of the standard M52A3B2 primer loaded with FA874 priming mixture. Results indicate that electric primer FAT3-E7 charged with FA-2 priming mix is superior with respect to temperature coefficient, velocity, pressure and action time.

Priming mixture FA-2 is superior to FA874 in the ignition of single base propellant. There is no significant difference in breech flash, muzzle flash or sparks. (vis)

150 Frankford Arsenal.

STANDARDIZATION OF LEAD STYPHNATE PRIMERS, PRIMING MIXTURES AND PROCESSES. FOURTH REPORT: OPTIMUM PARTICLE SIZE AND RANGE OF ZIRCONIUM IN PRIMING MIXTURES, by R. E. Donnard. June 1959. FA report no. R-1492. OAC project no. 56-155. Unclassified reports.

Six priming mixtures having identical composition, but containing different granulation ranges of zirconium, were prepared. The mixtures were assembled into six lots of percussion primers. A portion of the primers from each lot was tested for percussion sensitivity. Sixteen hundred primers from each lot were assembled into Cartridges, Caliber .30, Ball, M2 with IMR 4895 propellant. The cartridges were fired for velocity, pressure, hangfire, and function and casualty at -65°F, +70° F and +165°F. The tests were repeated using WC 852 propellant.

The best overall primer performance was obtained when the priming mixture contained zirconium with a particle size range of approximately 10-44 microns.

Since the particle size ranges of zirconium were mechanically prepared by the use of sieves, and, since particles larger than the control limits indicated by a particular sieve combination were observed under the microscope, it is believed that a range of 10-74 microns should be tested before an optimum range is specified.

151 Frankford Arsenal.

STANDARDIZATION OF LEAD STYPHNATE PRIMERS, PRIMING MIXTURES AND PROCESSES. FIFTH REPORT: OPTIMUM PERCENTAGE OF ZIRCONIUM IN PRIMING MIXTURE, by R. E. Donnard. June 1959. FA report R-1493. OAC project no. 56-155. Unclassified report.

The purpose of this study was to determine the optimum percent of zirconium in the priming mixture. Primers having 0, 2.2, 5.3 and 10.3 percentages of zirconium were assembled into Cartridges, Caliber .30, Ball, M2 with propellants IMR 4895 and WC 852. These cartridges were fired for velocity and pressure at -65°F, +70°F and +165°F. Hangfire tests were made at +70°F and -65°F.

Primer percussion sensitivity, primer characterizations, and ballistics and hangfire of caliber .30 cartridges were satisfactory when the priming mixture contained 10.3 percent of

zirconium. Therefore 10 percent zirconium is considered optimum for priming mixtures for caliber .30 percussion primers.

152 Frankford Arsenal.
STANDARDIZATION OF LEAD STYPHNATE PRIMERS, PRIMING MIXTURES AND PROCESSES. SEVENTH REPORT: STORAGE STABILITY, by R. E. Donnard. June 1952. FA report no. R-1494. OAC project no. 56-155. Unclassified report.

One of the requirements for a priming mixture to be considered standard for the Small Arms Ammunition Industry is that it possess satisfactory storage stability. It was the purpose of this study to determine the stability under accelerated storage conditions of priming mixture FA 950 in primer X5 in caliber .30, Ball, M2 Cartridges loaded with propellants IMR 4895 and WC 852.

153 Frankford Arsenal.
STANDARDIZATION OF LEAD STYPHNATE PRIMERS, PRIMING MIXTURES AND PROCESSES. EIGHTH REPORT: FINAL DESIGN OF PRIMING MIXTURE, by R. E. Donnard. July 1952. FA report no. R-1495. OAC project no. 56-155. Unclassified report.

The purpose of this study was to determine the effect of increasing the primer heat output over that obtained with primer X5, mixture FA 950 and to establish the best primer pellet weight using the priming mixture most compatible with propellants IMR 4895 and WC 852 in Cartridge, Caliber .30 Ball, M2.

Tests confirmed that approximately 10 percent zirconium in the priming mixture is optimum, and the X28 primer (9 percent zirconium and 5 percent PETN) was the most satisfactory ballistically. The most satisfactory range of primer pellet weight for the X28 primer was 0.62 - 0.71 grains.

154 Frankford Arsenal.
STANDARDIZATION OF LEAD STYPHNATE PRIMERS, PRIMING MIXTURES AND PROCESSES. NINTH REPORT: SUMMARY, by R. E. Donnard. August 1952. FA report no. R-1496. OAC project no. 56-155. Unclassified report.

A program to design and develop a standard Ordnance primer for caliber .30 and 7.62mm ammunition has been successfully concluded with the unanimous recommendation of the Primer Subcommittee to the Integration Committee on Small Arms Ammunition that FA 961 priming mixture in the No. 36 primer be standard.

155 Frankford Arsenal.
EVALUATION OF PERFORMANCE DATA TO ESTABLISH RELIABILITY CRITERIA FOR M3A1 INITIATOR, by David Jackson. December 1952. Industrial Engineering project (report) 53-0133-1A. Unclassified report.

An evaluation of the performance data of the M3A1 initiator, used in air crew escape systems, to determine probability limits for use as reliability criteria. Results indicate that the item, when it functions, will perform within a high degree of reliability with respect to minimum peak pressure and maximum ignition delay at -65°F, 70°F and 165°F. The probability of failure is practically one in an infinite number. (mw)

156 Frazer, J. C. W. and C. G. Bennett.
TIME FUSE ELEMENT. April 27, 1948. U. S. Patent no. 2,440,572.

A fuse element composition comprising an intimate mixture of finely divided nickel produced by distillation of mercury from a mercury-nickel amalgam, and an oxidizing agent which reacts exothermically with said nickel, a unit quantity of said mixture burning in a confined unit of space during a predetermined period of time and with production of substantially no gaseous products of combustion.

157 Garner, W. E., F.R.S. and J. Maggs.

"The action of ultra-violet radiation on barium and strontium azides." In ROYAL SOCIETY. PROCEEDINGS. v. A172. 1939. London. pp. 299-314.

This investigation reports that barium and strontium azides are decomposed by ultra-violet light at room temperature and that the thermal decomposition of these substances is accelerated by pre-treatment with this radiation.

The threshold for the absorption of ultra-violet light by azide ions in solution and in the solid state is 2600-2700A and that for for the photochemical reaction is in the same region.

Pre-illumination with ultra-violet light at room temperature shortens the induction period of the thermal process for barium azide.

Prolonged illumination with light of wavelength shorter than 2360A produced nuclei of metallic barium at room temperatures.

Solarization effects are observed in the region where nuclei are produced by the action of ultra-violet light.

The thermal decomposition of barium azide is unaffected by a field of 1250V/cm. (ama).

158 General Electric Company.

MANUFACTURE OF 20,000 ELECTRIC PRIMERS GERMAN TYPE TO FIT CALIBER .60 PRIMER POCKET, by K. R. Stadthaus. February 1944. Army contract no. W-36-038-ORD-1025. Bound in with FA report no. R-675. Unclassified report.

Reports the fabrication of 20,000 German type primers to fit the caliber .60 primer pocket.

The method of manufacture used for the components of this primer is not suitable for production. The present design of the resistance element does not lend itself to automatic manufacture. (ama)

159 Girsewald, Conway von.

USE OF HEXAMETHYLENE TRIPEROXIDE DIAMINE IN DETONATORS. 14 September 1912. Translated from German patent no. 274522. Picatinny Arsenal translation no. 83. April 1960. Unclassified report.

The use of hexamethylene triperoxide diamine as an initiating explosive is proposed. Use of this organic initiating mixture material instead of the commonly used salts of heavy metals, such as mercuric azide, lead azide and silver azide, is said to have these advantages: a) only gases are produced which means greater explosive effect, b) preparation is safer and simpler, and c) water does not affect this explosive. It can be used either alone or with other explosives. (reh).

160 Grant, R. L. and J. E. Tiffany.

"Factors affecting initiating efficiency of detonators." In INDUSTRIAL AND ENGINEERING CHEMISTRY. v 37: 1945. pp. 661-666.

The influence of the following factors upon the initiating efficiency of detonators was studied: base charge, priming charge, reinforcing capsule, and outside diameter of shell. The initiating efficiencies of laboratory-prepared detonations were determined by the miniature-cartridge test. Results indicated that the initiating efficiency increased in this order for the following base charges: 80 mercury fulminate-20 potassium chlorate mixture, tetryl, PETN, hexogen. The efficiency of priming compositions, as determined by minimum initiating charges, was as follows: (1) 80 lead azide-20 lead styphnate; (2) 80 lead azide-18 lead styphnate-0.5 aluminum-1.5 potassium chlorate and 60 lead azide-40 lead styphnate; (3) 100% lead azide, 80 lead azide-17 lead styphnate-3 aluminum, 40 lead azide- 60 lead styphnate and 75 DDNP-25 potassium chlorate; (4) 20 lead azide-80 lead styphnate and 80 mercury fulminate-20 potassium chlorate; (5) 100% lead styphnate. The use of a copper reinforcing capsule to enclose the priming charge increased the initiating efficiency of a detonator from one to three grades. As the outside diameter of a detonator was increased, the initiating efficiency of the detonator decreased as an approximate inverse straight-line function. Tests with the lead-plate test produced results in substantially opposite order to those of the miniature-cartridge test when the diameter of the detonator was varied. The initiating efficiency of the various kinds of detonators was calculated in terms of unit weight of explosive charge in the detonator and then systematically tabulated: detonators were thus classified according to initiating characteristics. This classification along with selected curves, revealed that hexogen-base detonators are uniformly more efficient than detonators with other base charges. These curves also disclosed that both quantity and quality of the

explosive charge in a detonator must be considered in relation to the initiating efficiency of that detonator.

161 Gray, P. and T. C Waddington.

"Thermochemistry and reactivity of the azides, II. Lattice energies of ionic azides, electron affinity and heat of formation of the azide radical and related properties." In PROCEEDINGS OF THE ROYAL SOCIETY. v. 235A; 1956. pp. 481-495. Unclassified report.

The thermochemical data of part I, the heats of formation and solution of the alkali-metal (group Ia) azides, are used in conjunction with other data to derive values for the lattice energies of alkali-metal azides, the heat of formation of the azide radical, for the electron affinity and hydration heat of the azide ion. Calculations by previous workers of these magnitudes which are not of course susceptible to direct measurement, have generally been erroneous.

The lattice energies of the alkali azides (kcal mole^{-1}) are: LiN_3, 194; NaN_3, 175; KN_3, 157; RbN_3, 152; CsN_3, 147. For potassium, rubidium and cesium azides a term-by-term theoretical calculation of the lattice energy which allows for the non-spherical character of the azide ion supports these figures, which are based on experimental data of part I.

The standard enthalpy of formation of the azide radical ΔH_f° (N_{3G}) is estimated to be 116 kcal mole^{-1}. The electron affinity of the azide radical E (N_{3G}) is 81 kcal mole^{-1}. These figures permit the evaluation of other lattice energies and the following values (kcal mole^{-1}) have been obtained: NH_4N_3, 175; CuN_3, 227; AgN_3, 205; TlN_3, 163.5; CaN_6, 517; SrN_6, 494; BaN_6, 469; and PbN_6, 516.

From the enthalpy of formation of the azide radical the bond dissociation energies D(X-N_3) in some covalent azides may be derived. D(H-N_3) is 96 kcal mole^{-1} and D(C-N_3) in aliphatic azides is about 83 kcal mole^{-1}.

162 Groocock, J. M., (A. R. D. E., Gt. Brit.)

"The thermal explosion of alpha lead azide." In TRANSACTIONS OF THE FARADAY SOCIETY. v. 54, pt. 10. October 1958. pp 1525-1536.

The thermal decomposition of α-lead azide in vacuo has been studied at temperatures sufficiently high for explosions to occur, and reaction rates have been measured up to the onset of explosion. The variation of the rate just before explosion with temperature and sample weight has been examined and the critical temperature below which explosion will not occur has been measured. The explosions are shown to result from the acceleration in the decomposition rate by autocatalysis and self-heating, the former being important at rates below $(dw/dt)_c$ and the latter at higher rates. It is shown that provided the total thermal emissivity h of the crystal is low the temperature within the crystal remains uniform as it self-heats and $(dw/dt)_c = hRT_f^2/2 \cdot 66$ EQ, where T_f is the reaction vessel temperature, E the activation energy for decomposition and Q the heat of reaction. Explosions cannot occur until the rate exceeds $(dw/dt)_c$; the critical temperature is roughly that at which the maximum rate of the isothermal decomposition = $(dw/dt)_c$, and this temperature is shown to be approximately independent of crystal size.

163 Hammond, J. W. and D. J. Keenan.

"BLASTING UNIT AND SHORT-CIRCUITING DEVICE." September 10, 1946. U. S. Patent 2,407,505.

A blasting unit comprising a battery housing, including a top wall formed with a pair of apertures, a slide carried by said top wall having a pair of apertures adapted to register with the aperture of said top wall, a pair of batteries in said housing having terminals confronting the apertures of said end wall, and a contact member including a body member, a pair of spaced apart contact members carried by said body member engageable in the apertures of said slide and said top wall for contact with said battery terminals, and normally engaged contact shorting members engaging said contact members, said shorting members being so constructed and arranged that one of said shorting members will be moved to disengaged position with respect to the other of said shorting members when said contact members are disposed in contact with the battery terminals.

164 Handforth, S. L.
ELECTRIC INITIATOR. July 13, 1937. U. S. Patent no. 2,086,548.

An electric blasting initiator, the firing circuit of which is provided with a discharging means, the resistance of which is an inverse function of the voltage applied thereto, whereby the susceptibility of said initiator to static electricity is substantially reduced.

165 Handforth, S. L., C. R. Johnson and G. H. Smith.
ELECTRIC BLASTING INITIATOR. August 20, 1940. U. S. Patent no. 2,212,118.

An electric blasting initiator comprising a charged shell, spaced leg wires entering the mouth of said shell, a plug of rubber-like material of the character described formed about said spaced leg wires and disposed in a position closing the mouth of said shell, said leg wires extending through said plug material substantially in a straight line and substantially parallel to each other, and a crimp extending around the circumference of said shell in the region enclosing said plug forcing the shell wall into and deforming said rubber-like plug to complete a water impervious juncture.

166 Handforth, S. L. and C. R. Johnson.
ELECTRIC BLASTING INITIATOR. April 8, 1941. U. S. Patent no. 2,237,932.

In an electric blasting initiator, a plug comprising a thermoplastic resin substantially free from crystalline ingredients, said plug serving as the sole means for spacing the leg wires in the firing circuit and as the sole sealing material to close said initiator, and a crimp extending around a circumference of the shell in the region enclosing said plug forcing the shell wall into and deforming said plug to produce a waterproof closure.

167 Harvard University. Office of Scientific Research & Development.
POLAROGRAPHIC ANALYSIS OF PRIMERS, by J. J. Lingane. March 30, 1945. OSRD report no. 4881. Unclassified report.

The report describes a technique whereby very small amounts of mixtures of inorganic compounds commonly found in primers and detonators, can be analyzed quantitatively by means of the polarograph. Investigations were confined to a typical mixture composed of potassium chlorate-cuprous thiocyanate, antimonous sulfide (stibnite) lead azide and mercury fulminate. The mercury fulminate was analyzed by dissolving a weighed sample in 2 M ammonium acetate in the steam bath, diluting it to a known volume, and recording the polarograph. The stibnite was analyzed by dissolving it in concentrated hydrochloric acid boiling to remove hydrogen sulfide dilution to a volume of 100 cc which was 1 M in free hydrochloric acid, and recording the polarograph. Analysis of the lead azide for lead content was made in the same manner as that for mercury in mercuric fulminates. The azide ion was determined cerimetrically.

168 Hassner, Alfred. (E. E. C. Corporation)
"Chemistry of explosives." In PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. 11-14 August 1959. Eighth conference held at Boulder, Colorado. pp. 7-16. Unclassified report.

A brief account of chemical data from the literature in connection with the structure and decomposition of explosives, particularly the azides. Such topics as energy of activation, covalent and ionic azides, heats of decomposition, and initiation and mechanism of explosions are covered. The fact that not all endothermic chemicals are explosive is investigated. Various explosives are examined in terms of their chemical structure and their internal bonding. rehl

169 Hawkes, A. S. and C. A. Winkler.
"The thermal explosion of lead azide." In CANADIAN JOURNAL OF RESEARCH. Ser. B, v. 25, 1947. pp. 548-565.

The minimum explosion temperatures for service and dextrin azides (about 315°C. and 275°C., respectively) are increased considerably by increase of surface volume ratio of the container and by compressing or wetting the charge with dibutyl phthalate before explosion. When wetted, the two azides were found to be similar in respect of minimum explosion temperatures and induction periods prior to explosion. Sensitization of service azide by preheating was found to be permanent. A limit to sensitization below the minimum explosion temperature was observed, and probably exists also for sensitization above this temperature. Wetting the charge with phthalate nullifies the sensitization. Although dextrin azide alone is more thermally sensitive than service azide, mixtures of the two containing 70% or more service azide showed a sharp change to service azide properties; the mixtures apparently are not exploded by the

dextrin azide they contain. The value of E in the expression $\ln t = \frac{E}{RT}$ + constant, where t is the induction period, has been determined for both the initial and final stages of reaction preceding explosion and found to be essentially unaltered. Minimum explosion temperature of single large crystals was shown to increase with crystal size. The data are interpreted as showing that the therma explosion of lead azide may result from self-heating, the heat of the pre-explosion reaction not being sufficiently dissipated from the material.

170 Hercules Powder Corporation.

IMPROVEMENTS IN OR RELATING TO STATIC RESISTANT ELECTRIC INITIATOR. April 18, 1956. Great Britain. Patent specification no. 747,935.

The construction of an improved static resistant electric initiator containing a semiconductive plug is described. Data reveals that when a static differential is applied between the lead wire and shell, it will discharge to the grounded shell outside the locus of the ignition composition, thereby eliminating an accidental firing.

This initiator has the following advantages: (1 ease of manufacture, (2) structurally stronger than initiators previously reported and (3) may be employed in any type of electric initiator to give complete protection from static discharge.

171 Hercules Powder Company. Radford Arsenal.

IGNITION OF ELECTRIC SQUIBS IN A UHF RADIO ENERGY FIELD, by H. W. Carter. May 2, 1956. Quality assurance investigation no. 486. Unclassified report.

A proposed installation of new intra-plant communications equipment operating on the 156 to 172 megacycle band, caused the question of ignitibility of electric squibs by radio frequency energy to be raised. Although considerable work in this field has been done previously (see literature listed in bibliography), very little of the data answered, with confidence, the behavior of the particular squibs in question in the transmitter fields which would be encountered at Radford Arsenal. To evaluate the specific potential hazard to the currently used M1A1, D-55, and Mk 1 Mod O squibs, the behavior of a number of each type in the field of a mobile transmitter was observed and recorded. Of the squibs tested, none fired at distances greater than six inches from the twenty-five watt output transmitting antenna under conditions for maximum transfer of radio frequency energy.

172 Hercules Powder Company. Radford Arsenal.

SUBSTITUTION OF ELECTRIC SQUIBS FOR NITROCOTTON IN THE PRIMING OF CLOSED BOMB CHARGES, by H. W. Carter. December 5, 1956. Quality Assurance Investigation 483. Unclassified report.

To reduce the occupational hazards associated with closed bomb testing of propellants, it is necessary to replace the highly inflammable priming materials, dry nitrocotton and E. C. Blank Fire Powder, with less dangerous substitutes. Four types of electric squibs were evaluated as relatively safe replacements for the primer pellet of dry nitrocotton, although a booster charge of Blank Fire powder was still necessary to reduce misfires. Reproducibility of the squib ignition technique was compared with that obtained with the currently standard priming procedure. Although three of the squib types apparently produce adequate ignition of charges, the precision of results is considerably lower than that obtainable with nitrocotton priming.

Adoption of squib ignition using any of the squibs tested is not recommended and an investigation of gas ignition systems, or other squib types, is indicated as the logical next step.

173 Herz, Edmund.

PRIMER COMPOSITION. April 27, 1911. German patent no. 258679. Picatinny Arsenal translation 92. June 1960. Unclassified report.

Use of diazo-perchlorates as initiating compounds in explosives is described. Being rich in oxygen, these compounds do not have the principal shortcoming of other aromatic diazo compounds. The desirable characteristics of diazo compounds -- explosive force, shattering power, stability, insensitivity to mechanical effects, low solubility -- are discussed. Use of halogens or negative groups is suggested to enhance the insensitivity of the compound to mechanical effects and to increase its resistance to water. A method of preparing the mononitrobenzene compound, which the author states is best for detonators is given. (reh)

174 Holex Incorporated.

TECHNICAL DATA SHEET HOLEX MODEL 1196A and 1196B IGNITION PRIMER.

Describes Holex ignition primer which was designed to satisfy the need for a precision, low brisance ignition cartridge and is available in a convenient, inexpensive, thread-in configuration. It is an electrically initiated explosive cartridge which will provide a highly reliable source for the ignition of black powder boron, smokeless powder, metal oxide boosters and similar propellants. (ama).

175 Huyett, D. D.

ELECTRIC EXPLOSION INITIATOR. December 2, 1947. U.S. patent no. 2,431,871.

A novel construction for an electric explosion initiator is described, wherein a more complete seal of the chamber containing the explosive charge is obtained by swaying a one-piece thermoplastic body (containing the explosive charge) shut around the leg wire. Heat as well as pressure is applied in this operation, which eliminates the need for a plug and thereby reduces the number of points where leakage can occur. (RH)

176 Inspector of Armaments. Great Britain.

JOLTING MACHINE. (December 1949). See OIN report no. 001116.

Brief description of jolt test used by the British to expose fuzes, primers, or tubes to conditions simulating road transport. Includes a photo and line drawing of the testing device. (reh)

177 Inspector of Factories and Workshops. Great Britain.

I. F. EXAMINER'S INSTRUCTIONS. APPARATUS, DROP TEST OF FUZES AND DETONATORS. OPERATION. April 1945. I. F. no. 632 with appendix A. OIN 001116. Unclassified report.

Lists stores required, experimental procedure, and maintenance: Appendix A is a drawing for the drop test apparatus. (ama).

178 Inspector of Factories and Workshops. Great Britain.

I. F. EXAMINER'S INSTRUCTIONS, DETONATORS, DROP TEST: WITH AMMENDMENTS A, B, AND C. April 1945 - May 1949. I. F. no. 169/2. OIN 00116. Unclassified report.

Lists instructions for operator's safety, stores required, preparation for proof (experimental procedure), and the procedure for destruction of detonators. Appendix A is a schematic drawing of the drop test machine. (ama)

179 Inspector of Factories and Workshops. Great Britain.

APPARATUS PROVING DETONATORS .4 in. PRESSURE BAR. December 1949. I. F. /IP1/no. PZZ. OIN 001116. Unclassified report.

Part I: General Instructions for Apparatus.
- A. Description of apparatus.
- B. Derivation of formulas for calculating pressure.
- C. Calibration of apparatus.
- D. Detailed instructions for performing the tests.
- E. Care of the apparatus.
- F. The plastic pellet and detonator holder combined.
- G. Specifications of bar, timepiece, and plastic holder.
- H. Solenoid control.
- I. Sources of error in pressure bar proof.

Appendix: - I. F. Inspection proof instructions. detonator 1.8 gr. ignited by igniter or fuze electric L. T.

Part II: Apparatus proof detonators pressure 0.4 in. bar: Operation of apparatus. (ama)

180 Integration Committee on Ammunition Loading. Initiating Components Subcommittee.

MINUTES OF THE FIRST MEETING HELD AT RAVENNA ARSENAL. 11-12 January 1955. Unclassified report.

Although called the first meeting, this meeting was the 9th of this group because of a change in the name of the committee.

Items discussed included the ff: loading of ammunition components; minimum charge weights for charges; sensitivity tests for relays and flash type detonators; output tests for detonators; gilding metal cups; elimination of powder on the exterior of detonators; deterioration tests; mass loading of M17 detonators; development of tests for characterization of primers; etc.

See also:
Kansas Ordnance Plant. EVALUATION OF COPPER WASHER EMPLOYED IN THE M-2 DELAY ELEMENT, .05 DELAY, by Marvin Edwards. 16 April 1954. Unclassified report.

---. SUPPLEMENTARY REPORT. 18 November 1954. Unclassified report.

Silas Mason Company. Iowa Ordnance Plant. REDESIGN OF ELECTRIC SQUIBS, IGNITERS, AND DETONATORS. 14 December 1954. Unclassified report.

---. REDESIGN OF M20 IGNITER. 19 November 1954. Unclassified report.

---. A STUDY OF REACTIONS OCCURRING IN A MIXTURE OF LEAD THIOCYANATE, POTASSIUM CHLORATE, AND WATER, by G. E. Frazer and L. R. Rothstein. Unclassified report.

Ravenna Arsenal. SPECIFICATION FOR PERCUSSION PRIMERS FOR USE IN MK2A4 PRIMERS, BY E. R. Sanders, Jr. 11 January 1955. Unclassified report. (ama)

181 International Resistance Co.

DESIGN AND DEVELOPMENT OF ELECTRIC INITIATOR, by W. A. Mulligan. March 1, 1957 to December 31, 1957. Monthly progress reports nos. 1 through 4, and Final report. Army contract no. DA-36-034-501-ORD-63. OAC project no. 56-103. Unclassified report.

Basic requirements were that: (a) the detonator must be capable of passing a continuous current of 1 ampere with a maximum surface temperature of 120°C in an ambient temperature of 125° F, and (b) the surface temperature of the resistor must rise almost instantaneously to at least 150°C upon application of 28 volts D. C.

These requirements were met by using two resistors in series. The first resistor, which is of the carbon film type, is capable of carrying a 1-ampere current without excessive heating. The second is a wire-wound resistor of much lower resistance; where a large current is applied to the circuit, it burns out creating a hot spot capable of initiating a powder in 10-15 milliseconds.

Described are unsuccessful attempts to meet the requirements for this initiator by varying the dimensions and other characteristics of a single tubular-type resistor. (reh)

182 Iowa Ordnance Plant.

SECOND MEETING OF INDUSTRY PRODUCT COMMITTEE ON DETONATORS AND RELAYS HELD AT IOWA ORDNANCE PLANT. 26-27 June 1945.

Brief list of subjects constituting the agenda are:
Production methods and equipment: - metal parts, lead azide preparation, primer and igniting mixtures tetryl preparation, filling cups, low charge indicators, Jones detonator loading machine, sealing, automatic equipment.
Inspection: - classification of defects, incoming inspection procedure, sequential plan for testing detonators, proving ground acceptance tests, waterproofness tests.
Packaging: Man Hour Standards: Safety:
Engineering: - integral cup and disc, M54 fuze design change, sealing of M17 detonator, substitutes for sand tests. (ama)

183 JANAF Fuze Committee.

A discussion of the need for study of the causes of unintentional initiations of explosive devices such as are used in fuze explosive trains. In THE JOURNAL OF THE JANAF FUZE COMMITTEE. Serial no. 14.0. Session of 13 February 1958. Unclassified report.

A series of accidents involving carbon-bridge primer initiations by static electricity gave particular impetus to this problem. The committee felt that a lack of technical information in view of the many possible mechanisms leading to unintentional initiations, makes it very difficult to take precautionary measures.

This journal article lists a number of general concepts or facts which are thought to be either obvious or at least not controversial. (ama).

184 Jenkins, H. P.

EXPLOSIVE CHARGE FOR DELAY FUZE. December 23, 1958. U.S. patent no. 2,864,726.

By mixing waxy materials including fatty acids such as stearic acid, metallic salts of fatty acids such as aluminum stearate and many others with primary explosives, an explosive charge is obtained which can be used to produce short time delays in fuzes. Tests have shown that, when lead azide and aluminum stearate are used, a mixture containing about 44.4% lead azide gives the longest delay.

Methods of mixing and testing such delay compositions are described in detail.

185 Johnson, C. R.

ELECTRIC BLASTING INITIATOR. September 14, 1937. U.S Patent no. 2,093,275.

In combination with a blasting initiator adapted for electrical firing and provided with insulated leading wires having uninsulated end portions, protective means comprising a metal of thin cross-section, said protective means jointly embracing each of said uninsulated end portions, whereby to protect said initiator from inadvertent firing by stray sources of electrical energy, said protective means having a resistance to tearing not substantially greater than that of pure aluminum foil approximately 0.008 in. thick.

186 Johnson, C. R. and Roland R. Nydegger.

ELECTRIC BLASTING INITIATOR. August 20, 1940. U. S. Patent no. 2,212,474.

A water impervious electric blasting initiator adapted to mechanical assembly, which initiator comprises a bridge plug of rubber-like material formed about the leg wires of said initiator, said plug having a reduced extension of the same material integral with its base, the material of said extension surrounding and closely adhering to said leg wires forming a waterproof seal between said leg wires and plug, and a charged shell crimped about said plug in waterproof relationship therewith.

187 Johnson, N.G., G. A. Naddin and M. E. Swanson.

IMPROVEMENTS IN DELAY CONNECTORS FOR EXPLOSIVE CHARGES, May 9, 1956. Great Britain. Patent specification no. 748,820.

A delay mechanism used for connecting two detonator fuses. The connector consists of a tubular shell within which is placed an enclosed primer charge, an encapsulated non-explosive mixture, an empty lead tube, an air gap and an enclosed heat sensitive explosive composition. The primer charge is lead azide while the explosive composition contains 90/10 lead azide-tetracene. A mixture (30/30/35) of magnesium, selenium and barium peroxide is used as the non-explosive filler. By carefully manipulating the device, delays can be varied from 2.1 to 3.2 milliseconds. (vis)

188 Johnson, C. R. and W. E. Kirst.

ELECTRIC BLASTING CAP. March 14, 1939. U. S. Patent no. 2,150,374.

In an electric blasting cap, a metal shell, a metal bridge plug adapted to close the open end thereof, leg wires extending separately through the bridgeplug in dielectric and water-impervious relation therewith, and a closure means comprising the upper portion of the shell wall extending over the clearance space between the plug and said shell wall, and mechanically compressing the shell wall about the plug to seal the cap against moisture penetration.

189 Kansas Ordnance Plant.

"Evaluation of copper washer employed in the M-2 delay element, .05 delay.", by Marvin Edwards. In Integration Committee on Ammunition Loading. Initiating Components Subcommittee. MINUTES OF THE FIRST MEETING HELD AT RAVENNA ARSENAL ON 11-12 January 1955. In April 1954. Unclassified report.

This work was done to determine the feasibility of assembling the M-2 delay element less the copper washer and the amount of tension required, a group of M-2 delay elements were cycled and tested. From the findings in this experiment, it is believed that an M-2 delay element less copper washer and only hand tensioned is as efficient as with the washer. (ama)

190 Kemp, M. D. (E. R. D. L.)
"Prevention of spontaneous detonation of beta lead azide during crystallization." In PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. 11-14 August 1959. Eighth conference held at Boulder, Colorado. pp 67-79. Unclassified report.

The monoclinic crystalline form of lead azide very frequently detonates spontaneously during crystallization. This destruction of the growing crystal makes the growth of larger crystals almost impossible. About 50% ethylene glycol by volume dissolved in water prevented the spontaneous detonation altogether, and growth of beta lead azide crystals to a length of 25 mm was made possible. The reason for this success appears to be that the probability of spontaneous detonation is related to the dielectric constant of the growing medium, and that the ethylene glycol reduces the dielectric constant. (reh)

191 Kenner, J. (College of Technology, Manchester, Great Britain).
"An outline of a theory of detonators." In NATURE, v. 163 1949. pp. 291-292.

This article outlines a theory of detonators. The author believes that in detonating compositions such as silver formate, the formate anions are associated with a heavy metallic cation in what may be described as covalent a covalent union. This constitutes a stage in the transition from the fully charged anion to the unstable radical. The process of transition is completed by a suitable supply of energy in the form of a blow, heat, or otherwise, and this stage is illustrated by the historic thermal decompositions of mercuric oxide and cyanide and by that of silver salts of carboxylic acids. Local decomposition of this kind in a mass of the detonating material will liberate energy, which on communication to immediately adjoining material will cause further decomposition lending to detonation.

192 Koenen, H. and K. H. Ide.
"Determining the sensitivity to friction of primers and other very sensitive explosives." In EXPLOSIVSTOFFE, v. 4, no. 1, January 1956. pp. 1-10. Picatinny Arsenal translation No. 8. Translated by G. R. Laehr. December 1956. Unclassified report.

Describes the development of a method which will be as free as possible from subjective influence, and which makes it possible to list numerically and arrange serially according to their sensitivity to friction all explosives which can be made to react in a porcelain mortar.

The indicated sensitivity scale for the explosives tested ranges from 2 to 36,000 g. In this method, the pestle load is the only variable; no other has to be taken into consideration. (ama)

193 Krause, B. H. (E. R. D. L.)
"Structure studies on freshly prepared and decomposing azides." In PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. 11-14 August 1959. Eighth conference held at Boulder, Colorado. pp 261-274. Unclassified report.

To study the irreversible changes which azides undergo when exposed to energy in the form of heat, electron or neutron bombardment, or X-ray irradiation, beta lead azide and alpha lead azide, both as single crystals and in the form of a powder, were irradiated with Cu-K2 X-ray irradiation and the decomposition effects studied by X-ray techniques. (reh)

194 Laird, K. V.
SUMMARY OF WORK OF LT. K. V. LAIRD FROM FEBRUARY 20, 1918 TO DECEMBER [illegible], 1918. January 7, 1918. Unclassified report.

Methods and programs for the inspection of primers for small caliber ammunition then being produced in quantity for World War I are described and discussed in some detail. Reference is made to two broad types of primers - those with the American-type anvil and those with the European anvil. (rh)

195 Lake City Arsenal.
M52A3 ELECTRIC PRIMER: MALFUNCTION INVESTIGATION, by D. L. Stonger. May 1957. Industrial Engineering Division report no. 57-1. OAC project nos. 56-185, 57-49. Unclassified report.

Experimental tests were performed to determine what effect the consolidation pressure used to compress the priming mixture has on the electrical resistance, electrical sensitivity, and action time of the M52A3B1 primer. Results of the tests conducted indicate that the consolidation pressure used to compress priming mixture has little or no effect on the electrical resistance and action time (at +65F.) of the M52A3B1 primer; but it does affect the electrical sensitivity of the M52A3B1 primer. Increasing the "compressed density" of the priming mixture appears to increase the electrical sensitivity of the primer as evidenced by a decrease in the V and V + 3 standard deviation values when increasing the consolidation pressure used on the priming mixture of the M52A3B1 primer.

196 Lake City Arsenal. Industrial Engineering Division.
STUDY OF GAS LEAKS, M52A3 SERIES PRIMER, by D. L. Stonger. June 1959. IED report no. 59-3. OAC project no. 58-72. Unclassified report.

Since the beginning of development and testing of electric primers for aircraft ammunition, there have been reports of primer gas leaks and the connection of said defects with decreased gun parts life, primer misfires, long action time and associated types of malfunctions. A study was initiated to ascertain the factual data available on primer gas leaks to determine if said defects are a real problem. Results of this study indicate that primer gas leaks are not currently considered a problem when firing electric primed ammunition through M39 or M61 guns when said ammunition is conditioned at -65F, normal ambient, or 165F.

197 Large, S. B
DETONATOR AND COMPOSITION FOR THE SAME. September 26, 1933. U. S. Patent no. 1, 928, 204.

As a new article of manufacture, a detonator including, in combination, a shell, a base charge of a solid explosive which is less sensitive to friction and impact than mercury fulminate, lead azide and diazodinitrophenol, a primary charge consisting of a mixture of a solid explosive substance of the general formula $C_mH_m+2(NO_3)m$ and a stabilizing agent, a perforated inner capsule pressed over the said primary charge, and an ignition medium for the said charge.

198 Large, S. B.
DETONATOR AND COMPOSITION FOR THE SAME. September 26, 1933. U. S. Patent no. 1, 928, 205.

An electric detonator comprising a primary initiating charge of a solid nitration product of polyhydric alcohol having the general formula $C_mH_m+2(OH)_m$, and a preformed fuse head comprising a bridge wire and a hot flash composition formed around the bridge wire prior to the insertion of the fuse head in the shell of the detonator, said hot flash composition lying in spaced relation to the initiating charge and being of a nature such as to deliver a semi-explosive burst or flame upon said polyhydric alcohol nitrate to bring about detonation thereof.

199 Large, S. B.
DETONATOR COMPOSITION. September 26, 1933. U. S. Patent no. 1, 928, 206.

A compound detonator including a secondary or base charge, and a primary explosive charge consisting of a mixture of a solid nitration product of a polyhydric alcohol of the general formula $C_mH_m+2(OH)_m$ and an additional solid explosive substance that is less sensitive to friction and impact than mercury fulminate and lead azide, precipitated together from solution.

200 Large, S. B.
DETONATOR COMPOSITION. September 26, 1933. U. S. Patent no. 1, 928, 207.

In a detonator, a primary detonator charge, consisting of one or more solid disaccharide nitric esters, an auxiliary flash composition for direct ignition of the primary charge, and means for separating the flash composition from the said primary charge, said flash composition being of such nature as to deliver a flame hot enough to ignite the charge.

201 Large, S. B.
SAFETY DETONATOR. September 26, 1933. U. S. Patent no. 1, 928, 208.

A compound detonator comprising a shell, a base charge therein of an explosive that is free of any ingredient that is as sensitive to friction and impact as mercury fulminate, diazodinitrophenol or lead azide, a primary charge of a "safety" type of primary detonator composition confined in said shell outwardly of the base charge, a confining capsule within the shell and bearing upon said primary charge, and an ignition medium consisting of an inflammable deflagrating material of such character and in such amount that the said ignition medium develops sufficient heat to effectively initiate the said primary explosive charge but insufficient heat and pressure to prematurely soften, melt, burst or injure either the confining shell or capsule prior to the detonation of the said primary charge.

202 Lawrence, R. W.

ELECTRIC BLASTING CAP. May 30, 1944. U. S. Patent no. 2,350,172.

An electric firing device resistant to detonation upon application of strong external heating having in combination a closed-end metallic shell; a base charge disposed in the closed end of said shell; a priming charge disposed above the base charge and comprising an intimate admixture of lead azide and tetryl, the said tetryl being present in the amount from about 30 to about 60% by weight of the said priming charge and adapted to desensitize the priming charge at a temperature below the ignition temperature of the lead azide: and an ignition charge disposed in a cavity type plug and above the priming charge forming an ignition assembly adapted to lower the rate of heat transfer external to said device to said ignition charge; said device adapted to retard ignition of said ignition charge until said priming charge is desensitized, upon application of strong external heating.

203 Lawrence, R. W.

BLASTING CAP. November 21, 1944. U. S. Patent no. 2,363,254.

A firing device insensitive to detonation by the external application of heat which comprises a casing containing a firing assembly and an explosive charge, an organic compound having a melting point between 60°C. and about 150°C. surrounding and maintaining the said explosive charge at least .01 inch from said casing, the said organic compound adapted to desensitize said explosive charge when the organic compound is heated to at least its melting point upon external application of heat to said device.

204 Lednum, E. T.

INITIATOR. December 17, 1935. U. S. Patent no. 2,024,586.

A blasting cap comprising in combination a charge of a secondary detonating compound, a charge of lead azide, and a shell of zinc-copper-silver alloy enclosing these charges, said alloy having the approximate composition of 95 - 98.5% zinc, 4 - 1.5% copper, 1.0 - 0.1% silver.

205 Lewis, H. A.

IGNITION COMPOSITION. July 18, 1933. U. S. Patent no. 1,918,920.

An ignition composition as the top charge in a composition blasting cap containing a charge of a secondary detonating compound and a priming charge, said top charge comprising sulfocyanate, an oxidizing agent and a solid low ignition point fuel.

206 Lieber, Eugene. (DePaul University)

"Recent advances in the chemistry of the azide radical." In PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. 11-14 August 1959. Eighth conference held at Boulder, Colorado. pp 17-26. Unclassified report.

Continued studies of the synthesis of lead imide ($PbNH$) are described. With individual V-shaped reactors, 95% pure lead imide has been produced. Frequency of detonation during synthesis has increased with purity of product. A theory to account for this increase (and for an accompanying bright orange modification of the imide) is presented, and extended to lead azide. Initial studies of the azide are described. Achievement of a cyclic transformation of an azide, previously considered impossible, is described. The transformation involved the AlN_9 catalyzed isomerization of carbamyl azide to tetrazolinone. (reh)

207 Ling, D. S. (F. E. C. Corporation).

"Speculations on the initiation of explosion in lead azide." IN PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. 11-14 August 1959. Eighth conference held at Boulder, Colorado. pp. 211-214. Unclassified report.

Postulates that a direct reaction between two azide radicals (involving the reaction $2N \rightarrow 3N_2 + Q$) occurs when the heavy metal azides explode. It is pointed out that the Coulomb barrier produced by the effective charge carried by the radicals tends to keep them apart, but that the radicals of the heavier azides (which explode most readily) are more nearly neutral than those of the lighter azides. Mathematical support of the possibility of such direct reactions is presented. Further study of such a mechanism is recommended. (reh)

208 Love, W. F. (P. E. C. Corporation)
"Thermal and photolytic decomposition in the metallic azides." In PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. 11-14 August 1959. Eighth conference held at Boulder, Colorado. pp 247-260. Unclassified report.

Various theories -- of Mott, Mott-Gurney, Bartlett-Tompkins - Young, and workers at the University of Texas and the University of Arkansas -- are discussed. Possible further experiments are suggested, including a detailed study of electrical conductivity; use of either thermoelectric power or Hall effect measurements to identify the sign of the charge carriers; experiments at low temperatures to learn more about optical absorption, irradiation effects, and magnetic susceptibility; studies of dislocations, and diffusion measurements. The author recommends much further experimentation, stressing the importance of efforts to prepare single crystal specimens of high purity as free from defects as possible. (reh)

209 Lyte, G. A.
DETONATOR. October 17, 1944. U. S. Patent no. 2,360,698.

A blasting cap consisting of three separately charged and pressed explosive charges, namely, an initiating charge, a secondary charge and a main charge which are charged in inverse order: the initiating charge consisting of less than .10 gm. lead azide, the secondary charge consisting of .25 to .35 gm. of a mixture of lead azide and trinitrotoluene, the ratio of weight of lead azide to the weight of trinitrotoluene varying between .25 and .429, and the main charge comprising a mixture of pentaerythritol tetranitrate to trinitrotoluene, by weight, varying between 5.67 and 2.33.

210 McFarland, D. M.
ELECTRIC BLASTING CAP PACKAGE AND METHOD OF FORMING THE SAME. December 4, 1934. U. S. Patent no. 1,983,141.

An electric blasting cap package comprising a detonator and its leg wires, said leg wires being bent to form a plurality of progressive and non-intertangled folds of substantially uniform length extending longitudinally of the detonator, the group of loops being such in number that they may complementally substantially completely encircle and house the detonator, and a restraining means about said folds.

211 McFarland, D. M.
METHOD OF AND APPARATUS FOR FIRING EXPLOSIVES. May 25, 1937. U. S. Patent no. 2,081,633.

The method of firing electrical firing elements which comprises generating current by a single manual operation of a shunt wound blasting machine, imparting current so generated to a plurality of circuits, each of which comprises at least one electrical firing element connected in series, through a time switch mechanism adapted to actuate each circuit at progressively different times; the time intervals between the actuation of consecutive series circuits being within the range of 0.005 to 0.065 second.

212 Macintyre, W. M. (P. E. C. Corporation).
"Crystallography of the azides." In PROCEEDINGS OF THE MARTY SYMPOSIUM AND CONTRACTORS CONFERENCE. 11-14 August 1959. Eighth conference held at Boulder, Colorado. pp 81-91. Unclassified report.

Use of X-ray analysis to secure information on the dimensions of the azide ion in heavy metal azides, such as lead azide, is discussed and a successful - though lengthy and expensive -- method for doing so. The lead and azide ions appear to lie closer together than their equilibrium distance. This fact may account for the instability of lead azide. (reh)

213 Majrich, M. M.
"Contribution to the theory of explosions." In MEMORIAL DE L' ARTILLERIE FRANCAISE. v. 15. p. 367. A translation by N. Ruckman. Ballistic Research Laboratories, Aberdeen Proving Ground. December 3, 1936. BRL report no. 64.

A review of the literature which concerns molecular phenomena which take place during the initiation and propagation of an explosion. Summing up the results of these investigators, it can be said that the detonation of explosives is initiated by pressures much lower than those commonly believed. The value of these pressures of detonation begins at about 1,000 atmospheres. The principal condition for the detonation is the rapidity of the formation of this pressure.

The new method of obtaining the priming of explosives is in accord with the modern ideas about the initiation of explosions. The more rapid the combustion of the primary explosive, the shorter is the wave of shock and the greater the potential attained. On the potential depends the degree of activation and the number and distance of the activated molecules.

Each explosive has as many different energies of activation as the different orders of decomposition. The absolute value of these energies of activation becomes greater to the extent that the decomposition approaches a detonation. At the same time, the size of the molecular products of decomposition diminishes, while the energy evolved increases. The initiation of the detonation of a mixture of mercury fulminate with paraffin by the shock of a steel bullet may be explained in an analogous manner, as well as the priming by explosives to rapid combustion, i, e, by activation by displacement of the molecules. (ama)

214 Martin, C. A.
PRIMER. July 15, 1947. U. S. patent no. 2, 423, 837.

This invention proposes that a fusible alloy (with a melting point of under 100°C) be used in primers as a means of increasing the speed and uniformity of ignition of the explosive charge. This effect is achieved as follows: The fusible alloy (D'Arcet's alloy and Wood's alloy are examples) would be liquified by the heat of combustion of the priming charge and incandescent droplets of it would be disseminated throughout the charge to be ignited, each droplet sewing as an energy source to spread the burning throughout the charge.

215 Maryland. University.
STUDIES, RESEARCH AND INVESTIGATIONS DIRECTED TO IMPROVEMENT OF EASE OF OPERATION AND EFFICIENCY OF ELECTRICAL BLASTING EQUIPMENT, by J. S. Smith. (no date) Final report for the period 1 July 1948 - 31 December 1949. Army contract no. W-44-009-ENG-60. Unclassified report.

Two broad topics were investigated: (1) ways of increasing the initiating efficiency of blasting caps, and (2) ways of reducing hazards that are encountered in using electric blasting caps. The relative merits of various methods of testing detonators (including the sand bomb, miniature cartridge, lead plate, nail, and iron oxide-TNT tests) were studied, and the initiating efficiency, electrical characteristics and storage and waterproofness characteristics of various commercial and military caps were compared. Also covered by the investigation were: series vs parallel firing; machine blasting vs power line blasting; methods of reducing or eliminating various types of power loss (including the effects of induction, static electricity, radar, and radio); and circuit-testing devices. There are also sections on inductance and capacitance in the circuit, methods of determining ideal power for electrical blasting, suggested changes in the Army special blasting cap, and what should be included in a quarry blasting kit. The eight appendixes include a treatment of low-tension electric shot firing, a report by Consolidated Gas and Electric Company of Baltimore on the effect of high voltage transmission lines on electric blasting cap performance, a Dupont technical service bulletin (No. 8) on "Hazards from Extraneous Electricity", an Evans Signal Corps Laboratory memorandum on the effect of radio frequency energy, and a list of relavant patents. (rh)

216 Maryland. University.
THE STEEL PLATE DENT TEST, by W. L. Monson and L. J. Reid. August 31, 1955. Final report. Contract No0921s-3179. Unclassified report.

This research consisted of a study of those factors which were relevant to the specification of a workable steel plate dent test. A copy of the existing lead disc, test machine was constructed. The anvil design and minimum size of test piece that could be used with no change to this machine was determined. The suitability of round and flat bar stock for use in fabricating test pieces was evaluated.

The sensitivity of the test for distinguishing between strong and weak detonators was investigated. Those factors such as test piece preparation and hardness which were found to influence the sensitivity of the test were evaluated as far as possible without a knowledge of the degree of correlation between the test and capacity of the detonator for initiation of explosives.

A flash detonator holder was designed and tested.

Recommendations were made as a result of these preliminary investigations which were intended to serve as a starting point for a more extensive evaluation of the steel plate dent test in practice.

217 Medlock, L. E.

INCENDIARY COMPOSITIONS AND ARTICLES COMPRISING SAME. 21 December 1955. Great Britain patent no. 742,283.

These non-detonating, waterproof compositions consist of pulverulent oxidizing and reducing agents distributed uniformly through rubber or artificial rubber. Used for such purposes as fuses, igniter cords, and incendiary charges. (ama)

218 Menke, J. F. and E. H. Doerpingaus.

IMPROVEMENTS IN OR RELATING TO ELECTRICAL PELLET PRIMERS. 11 July 1956. Great Britain patent no. 752,724.

These pellets are assembled into fuses. Electrodes are connected by a thin metal film coated on a glass bead. The bead is spherical to give high mechanical strength for pressing the assembly into the ignition material.

It is suggested that these primers could be used for pyrotechnical purposes, for igniting purposes in projectile fuzes, and for other fuzes.

Listed advantages are: instantaneous ignition, multiple simultaneous ignition; rugged construction; reliability; permits continuous fabrication. (ama)

219 Miller, A. B.

ELECTRIC BLASTING CAP. August 22, 1944. U. S. Patent no. 2,356,337.

An electric blasting cap having its component parts prefabricated and adapted to mechanical assembly which comprises a bridge plug of dielectric material formed about a bridge assembly, said bridge plug having at least one groove about its periphery, and a relatively thin sleeve of a resilient material interposed between said bridge plug and a charged shell, said charged shell crimped to engage said groove in the bridge plug, the elastic material being highly compressed whereby the resilient properties thereof compensate for differences in thermal expansivity between the plug and shell to form a water impervious cap.

220 Miller Metal Products, Inc.

DESIGN AND DEVELOPMENT OF LIGHTER, FUSE, WEATHERPROOF, T2, by M. G. Angelos. April 1954 to February 1957. Monthly progress reports nos. 30-1 to 30-23 and summary report no. 30-101. ORD project no. TA3-5306, Army contract DAI-36-034-501-ORD-(F)-30. Unclassified reports.

Effectively and consistently ignites the M700 safety fuse in air at -65°F to 125° F or under fresh or sea water at a depth of at least 30 inches after being submerged for at least 6 hours. The lighter is made of nylon except for the firing system, which is of stainless steel. 100% prevention of fuse "blow-outs" is achieved by venting the firing chamber into the upper body to relieve the pressure built up by the burning of the primer and the fuse. Rubber seals are used at both ends to waterproof the lighter. (reh)

221 Moser, H. H.

IMPROVEMENTS IN OR RELATING TO CONTACT IGNITERS. July 11, 1956. Great Britain. Patent specification no. 752,365.

A contact igniter consisting of chemical substances has been devised and tested. The operation primarily consists of bringing two chemicals into contact. One of the chemicals is an oxidizing material while the other is a contact material. A chemical reaction takes place at the surface and produces heat. A third material, the igniter, is fired by the heat generated from the surface reaction. A silver, potassium or calcium permanganate - semipyrophoric iron mixture is used as the oxidizing material. The contact material is either pure hydrazine or a hydrazine salt. (vis)

222 Murphy, M. F.

"The status of gasless delay development in the Navy". In SYMPOSIUM ON BASIC PYROTECHNICS RESEARCH. Held at Picatinny Arsenal. 14-15 February 1957. Unclassified report.

The principal problem in the use of manganese gasless delays is the instability of manganese at high humidity and control of particle size distribution of the fuel. A chemical deactivation treatment is currently used involving partial oxidation by dichromation and coating the oxide layer with a thin film of stearic acid. This treatment increases the time that manganese powder can be subjected to high humidity (95% R.H.) without seriously affecting its performance as a delay fuel.

Particle size distribution limits of the manganese fuel have been determined by comparing performance and particle size as determined by the Sharples Type XC Micromerograph.

Fuels with weight average diameter finer than 10 microns and having specific surfaces over approximately 1100 square centimeters per gram will over oxidize during the deactivation treatment. Fuels with weight average diameters larger than 14 microns and having specific surfaces below 900 square centimeters per gram will not burn reliably at -65°F and will provide only a limited range of burning times when formulated into delay compositions.

223 Napier, S. E., W. J. Powell and A. R Ubbelohde.
"The sensitiveness of initiators to friction. Apparatus for measuring relative sensitiveness to grazing friction with or without grit". In ROYAL SOCIETY OF LONDON, PHILOSOPHICAL TRANSACTIONS. v. A241; 1948. pp. 265-272.
Part III, section 2 of the sensitiveness of explosives.

Apparatus is described for subjecting explosive compositions to grazing friction between surfaces of various materials, which can be made to move at various relative velocities up to about 15 ft/sec. Conditions for obtaining reproducible results are detailed.

Tests on a number of initiators by means of this apparatus give an order of relative sensitiveness to rubbing between smooth surfaces of steel. When the rubbing occurs in the presence of grit, it is found that certain initiators such as lead azide and lead styphnate have their sensitiveness notably enhanced compared with others, such as mercury fulminate.

Photomicrographs of the explosives after rubbing show very considerable break-up of the crystals even when no detonation has occurred.

224 Nash, H. E.
DELAY CAP. April 30, 1935. U. S. Patent no. 1,999,820.

A delay cap including a rigidly and permanently sealed ventless casing, an igniter charge, a detonator charge and a fuse, the powder train of the fuse comprising in admixture a substance from the group consisting of sulfur, selenium and tellurium, an oxidizing agent which when burned with said substance will react without the evolution of gas in sufficient quantity to rupture the casing and an inert substance which will exert a control on the burning rate of the mixture.

225 Nash, H. E.
ELECTRIC BLASTING CAP. January 9, 1940. U. S. Patent 2,186,426.

An electric blasting cap including a shell, a detonating charge, a bridge wire and an igniter charge placed around said bridge wire, comprising a finely ground mixture of diazodinitrophenol and an oxidizing agent, which does not decompose the diazodinitrophenol at least the major portion of said mixture having a particle size range of about 1 to about 40 microns admixed with a binder.

226 Nash, H. E.
ELECTRIC BLASTING CAP. January 9, 1940. U. S. Patent 2,186,427.

An electric blasting cap including a shell, a detonating charge, a bridge wire and an igniter charge placed about said bridge wire comprising finely ground diazodinitrophenol at least the major portion of which has a particle size range of about 1 to about 40 microns admixed with a binder.

227 Nash, H. E.

BRIDGE PLUG ASSEMBLY. June 1, 1943. U. S. Patent no. 2,320,880.

An electric firing device of the character described, including, in combination, a casing, an explosive charge and a firing assembly adjacent said charge, said assembly comprising a pair of leg wires disposed in spaced relationship to each other, a bridge wire electrically connecting said leg wires, said bridge wire being made of zirconium and having a metallic oxide adhering to said wire whereby said bridge wire is caused to be pyrophorized under a relatively low electrical potential during a relatively short period of time.

228 Nash, T., W. J. Powell and A. R. Ubbelohde.

"The sensitiveness of initiators to friction. Temperature Coefficient." In ROYAL SOCIETY OF LONDON, PHILOSOPHICAL TRANSACTIONS. v. A241; 1948. pp. 272-280. Part III, section 3 of the sensitiveness of explosives.

By arranging Service initiators in a scale of increasing sensitiveness, it was shown that a different order was obtained: (a) when the rubbing surfaces were coated with standard emery paper, so that the friction was due to particles of hard grit; (b) when the rubbing surfaces were of steel; (c) when grit was introduced between steel surfaces.

Initiators such as mercury fulminate show much the same sensitiveness in all three cases, but others, such as Service azide, are notably more sensitive under the action of grit. The experiments described in this section were designed to give additional information on the nature of grit sensitiveness in particular, by investigating: (1) the effect of raising the temperature of the rubbing services; (2) the deadening produced by wetting the explosive with various liquids.

The relative probability of initiation by grazing friction was determined for a range of velocities of the rubbing surface, as described in the part quoted above. Principal changes in determining grit sensitivities were: (1) Graded emery powder was mixed with the initiator which was then rubbed between steel surfaces. One reason for eliminating the use of paper was the uncertainty arising from the effect of heating or wetting on the standard emery paper. (2) An initiator balance was used to weigh out standard quantities of compositions for each test. These were sprinkled over a constant area of the steel on the tilting table, through a small multiple sieve. (3) The temperature of the tilting table, and of the thin layer of powder on it was maintained by electric heaters, at various temperatures up to 300°C. (4) To investigate the deadening effect of liquids, drops or fine spray were applied to the layer of composition. Liquids used included water and glycerine solutions with and without the addition of capillary active substances, and ethyl and butyl alcohols.

229 Nasledov, D. N. and A. Yu. Khalilov.

"The electrical properties of InSb." In ZHURNAL TEKHNICHESKOI FIZIKI. v. 26. (1955). pp. 1, 6-14. Translated by E. R. Hope. June 1956. Directorate of Scientific Information Service report no. T 215R.

This paper examines the electrical properties of indium antimonide with p-type conductivity (holes) and with n-type conductivity (electrons). Points studied are: the temperature-dependence of the conductivity from 1.3 to 673°K, the Hall effect up to magnetic field intensity 33,000 oersteds, and the variation of resistance in the magnetic field. The change of sign of Hall's coefficient under the influence of the magnetic field is studied at different temperatures.

230 National Bureau of Standards.

PRELIMINARY REPORT OF A METHOD FOR TESTING AND EVALUATING ELECTRIC DETONATOR CHARACTERISTICS FOR FUZE APPLICATIONS, by George R. Keehn. 7 August 1953. 16. I-TM-21.

A modification of the Dodd testing method was developed, in that a detonator known to perform adequately in service was used, remove all benefits a fuze contributed and then introduce barriers to the point of failure.

231 National Defense Research Committee. O. S. R. D.
THE MICROSCOPIAL EXAMINATION OF PRIMER COMPOSITIONS, by A. T. Blomquist. 1 August 1944. OSRD report 3757. Unclassified report.

Primer and detonator constituents can be identified using only a microscope. It is possible to make a complete analysis, using only a few milligrams of sample, in a very short time. Useful qualitative tests for the identification of 29 primers are described. Crystallographic data on 22 of the 29 primers is presented. (vis)

232 National Defense Research Committee. O. S. R. D.
POLAROGRAPHIC ANALYSIS OF PRIMERS, by J. J. Lingane. March 30, 1945. OSRD 4881. Unclassified report.

Describes a technique whereby very small amounts of mixtures of inorganic compounds commonly found in primers and detonators can be analyzed quantitatively by means of the polarograph. The materials analyzed included cuprous thiocyanate, antimonous sulfides, lead azide and mercury fulminate. A detailed method of analysis is included in the report.

233 National Gypsum Company. Kansas Ordnance Plant.
MASS LOADING OF M-17 DETONATORS. 1953. Unclassified report.

A good comparative review of the various methods of loading detonators. Described in detail are: hand line, Jones Loader, and mass loading. Data are given which conclusively show the advantages of the mass loading technique and establish its feasibility and economy. Also pointed out is the increased safety with regard to the number of operators is reduced to a very small percentage of other methods. (ama).

234 Naval Ammunition and Net Depot. Seal Beach, California.
SPECIAL QUALITY EVALUATION OF PRIMER DETONATORS (VARIOUS MODELS AND DELAY TYPES). 15 April 1955. Report no. QE/SB 55-7. Unclassified report.

As noted in previous reports, a low level of operability can be expected for the primer detonator population in general; considered collectively, 12.5% (222 out of 1,770) of the sample units were attribute failures on the drop test. Due to the heterogeneous nature of the material, however, this figure should not be applied to any particular subgroup. One of the 91 lot samples tested, 41.8% (38) evidenced perfect performance while several ranged as high as 86.7%(n = 15, c= 13) defective.

Attempts to establish homogeneous subgroups for sentencing purposes by age, type and manufacturer were unsuccessful. Although primer detonators of the same lot prefix series generally exhibited a tendency to be of like quality, it becomes increasingly apparent that the most effective method of segregating good from bad quality material is on a lot-by-lot basis.

Adherence to the 1% AQL Plan specified in reference (a) as a standard for sentencing recommendations would result in 63.1% (20, 424) and 36.9% (11, 969) of the units concerned being sentenced as serviceable and unserviceable, respectively. Based on the sample findings, the units which would be retained in serviceable stock only averaged 0.4% (n = 814, c= 3) defective while those which would be rejected averaged 22.9% (n = 956, c = 219) defective. Thus, by disposing of this group of highly defective material, the overall quality level of primer detonators remaining in serviceable stock could be raised from 87.5% to 99.6% effective.

235 Naval Ammunition Depot, Crane, Indiana.
EVALUATION OF M3A1 INITIATORS, LOT FA-2-62 (CARTRIDGE LOT FA-1-159), by R. D. Neathammer. 16 February 1959. Unclassified report.

Presents results of tests performed by NAD Crane on 20 Initiators, M3A1, from Lot FA-2-62 to determine the effect of extreme temperatures on the initiator.

236 Naval Ammunition Depot. Crane, Indiana.
RESULTS OF 1959 SURVEILLANCE TESTS OF M3A1 INITIATORS, By R. D. Neathamer. 30 September 1959. QEL report no QE/C 59-100. Unclassified report.

Presents results of surveillance tests of 137 serviceable and 10 unserviceable M3A1 and M3 initiators. These results revealed no defects of any kind. No inferences can be made on the unserviceable initiators since only 10 were tested. (ama)

237 Naval Ammunition Depot. Crane, Indiana.
SPECIAL TEST OF M3A1 INITIATORS, LOT FA-2-73, by R. D. Neathammer. 30 September 1959. QEL report no. QE/C 59-126. Unclassified report.

Presents results of tests conducted on 81 M3A1 initiators from lot FA-2-73 which investigates effects of temperatures up to +200°F.

No defects were found in the initiators tested. It is concluded that high temperatures up to 200°F have no detrimental effects M3A1 initiators. (ama)

238 Naval Ammunition Depot. Oahu, T. H.
FIRING DEVICES, PULL RELEASE TYPE M3; SPECIAL INVESTIGATION OF, by R. S. Burdick. 10 March 1959.

This is the final report describing a special evaluation of the depot's stocks of firing device, pull release type M3 which were declared unserviceable because of 100% malfunction with 10% critical defects. It was recommended that the: remaining unidentified rounds of this item be declared unserviceable; undertaking of a reading survey be directed; proper lubrication be required in any new manufacture of this item.

A mechanical triggering mechanism containing a percussion cap, the device was designed to actuate by pull or release in the tension of a taut strip wire. It is used in conjunction with antipersonnel mine M3 and in setting up booby traps.

Defects found were: plastic protector missing; and frozen ratchets. (ama)

239 Naval Ammunition Depot. Oahu, Hawaii.
1959 SURVEILLANCE OF ELECTRIC DETONATORS, MK 51 MOD 0. 18 June 1959. Report no. QE/OH 59-CO51. Unclassified report.

Presents the results of the evaluation of electric detonators, MK 51 Mod 0, stored at NAD Oahu and partially completes QE/OH Task No. 107.

With the exception of two units with oversized corrugation diameters, all sample units met with the visual, non-functional and functional requirements. Detonators with oversized corrugation diameters will be detected furing the assembly of the rocket units. (ama)

240 Naval Ordnance Laboratory
ELECTRIC DETONATORS AND SQUIBS-CHARACTERISTICS AND USE:by C. A. Borcher. 1 June 1945. NOLM report no. 7355. Unclassified report.

A compilation for quick reference to explosive and detonator information. Covers commercial uses of detonators, primacord, time fuse and associated material used in general blasting operations. Does not consider military explosives, except where a comparison of these materials is tabulated. (ama)

241 Naval Ordnance Laboratory.
DEFINITION OF INITIATOR TYPES, by S. W. Booth. 29 September 1947. NOLM no. 9341. Unclassified report.

Various terms, such as squib, primer, detonator, and initiator are commonly used to describe those parts of an explosive train whose function is to initiate the explosive action. Common usage in NOL technical reports is defined herein.

242 Naval Ordnance Laboratory.
A DIFFERENTIAL RESISTANCE METHOD FOR MEASURING IGNITION TIMES AND THRESHOLD FIRING ENERGIES OF ELECTRIC PRIMERS, by V. M. Korty. 4 November 1947. NOLM report no. 8636 revised. Unclassified report.

In February 1946, TM-1 sought to develop a new method for measuring ignition times, threshold firing energies, and bridge wire breaking times. Investigation was made of the usefulness of oscillograms of resistance-time curves of electric squibs activated by constant current. A rough theory was worked out and data were obtained from twenty-three runs on the D-55 electric squib that is used in rocket igniters. Studies of appropriate literature revealed no American work of this type. British work, which to some degree paralleled the investigation, was brought to TM-1's attention by WA. Further search of the literature revealed German work that also bore on this problem.

243 Naval Ordnance Laboratory.
DEVELOPMENT OF 50-MILLISECOND DELAY FOR LOW ENERGY ELECTRIC PRIMERS, by W. W. Rymer. 18 November 1948. NOLM report no. 9896. Unclassified report.

In an effort to find a satisfactory material for a 50-millisecond delay in the low energy electric primer being developed at the Naval Ordnance Laboratory, twenty-five straight explosives have been tested. In addition, considerable study has been made of the possibility of regulating burning times by coating the explosives with various materials. Lithium styphnate, cesium styphnate, and normal lead 2,4-dinitroresorcinate give essentially satisfactory delay times when fresh, but their aging characteristics are not yet known. Normal lead mononitroresorcinate coated with 2.5% shellack or 8% polystyrene gives good results, and indications are that it ages well; several other coated materials show promise. A two-increment combination of normal lead 2-mononitroresorcinate and D-55 black powder also gave satisfactory delay time.

244 Naval Ordnance Laboratory.
SAND TEST OF PRIMERS AND DETONATORS. August 2, 1949. NAVORD OD 7231. Unclassified report.

Operating instructions are given for the use of Mark 146 Mod. O, Mark 147 Mod O, Mark 148 Mod O, Mark 149 Mod O, Mark 150 Mod O, Mark 151 Mod O, and Mark 158 Mod O. test sets. The scope and utility of these sand bomb testing facilities is discussed in terms of the testing of primers and detonators used by the Navy. The apparatus dealt with conforms, as nearly as possible, to the methods described in Bureau of Mines Bulletin 346.

245 Naval Ordnance Laboratory.
A DETONATOR FOR UNDERWATER USE AT HIGH PRESSURES (2,000-6,000 psi), by R. H. Streeau and C. W. Randall. 31 August 1949. NOLM report 10,375. Unclassified report.

Describes the development of a special detonator embodying the features of a phenolic plug and a sprayed metal contact on a tungsten bridge, and using a novel method of sealing. This detonator was to be used in deep water studies and had to be capable of withstanding hydrostatic pressure of 2,000 psi to 6,000 psi. The problem of water leakage was solved by the use of P ttman's Cement in sealing grooves.

246 Naval Ordnance Laboratory. U 75576
SENSITIVITY AND OUTPUT INSTRUMENTATION FOR QUALITY CONTROL OF FUZE PRIMERS, by F W. Hayward. 12 September 1949. NOLM report no. 10222. Unclassified report.

Describes necessary equipment to be employed with the Mk 135 and 135 Primer Test Sets. The accessory equipment is intended to greatly improve the quality of the data obtained from the test sets by providing information of the time required to fire each primer and also information on the relative heat output of each primer. The firing time measurement is accomplished by attaching simple and rugged capacity-change pickups to the appropriate drop test machine in such a manner than an electric chronograph may be started at the instant that explosion reaction products are expelled from the initiated primer. The relative heat output measurement is obtained by placing a sturdy thermocouple in proximity to the fuze primer, and obtaining a steady reading of a meter which is proportional to the peak thermal emf of the thermocouple.

247 Naval Ordnance Laboratory.
TORSIONAL BALLISTIC PENDULUM FOR TESTING ELECTRIC FUZE PRIMERS (ELECTRIC PRIMER TEST SET MK 172, MOD O), by J. B. Lord. 12 September 1949. NOLM report no. 10400. Unclassified report.

Describes a torsion type ballistic pendulum for comparing the outputs of electric fuze primers of a given type in terms of the impulse delivered to the system. The instrument consists essentially of a heavy metal cylinder bearing a pair of opposing radial arms, each of which supports a firing chamber at its outer extremity. The system is suspended by taut piano wires which hold the axis of the central cylinder vertical. When the sample primer is fired, the firing chamber orifice directs the jet of gases in a horizontal direction, normal to the radial arm. The rotational energy thus delivered to the pendulum determine the maximum angle through which the pendulum swings against the restoring torque of the piano wire suspension. This maximum deflection is used as a measure of the output of the primer. This equipment will be designated as the "Electric Primer Test Set MK 172, Mod. O".

248 Naval Ordnance Laboratory.
PROPOSED DESIGN OF LOW CURRENT OHMMETER FOR USE WITH LOW ENERGY ELECTRIC PRIMERS AND DETONATORS, by J. N. Ayres. 28 September 1949. NOLM report no. 10458. Unclassified report.

A company has been found which shows promise of being a source of supply for special high sensitivity meters. Around these meters can be built a circuit which will measure the resistance of electric primers with a current through the primer which is well below the maximum safe current ratings for present designs or conceivable future designs. Considerable need has been found in the NOL for an instrument of this nature.

249 Naval Ordnance Laboratory.
A DEVICE FOR THE MEASUREMENT OF TIMES OF THE ORDER OF ONE MICROSECOND, by R. Stresau. 15 October 1949. NOLM report no. 10434. Unclassified report.

A device has been constructed which measures short intervals of time by delivering a square wave of known amplitude and duration equal to the interval being measured to the heater of a vacuum thermocouple. The temperature rise of the heater, which is proportional to the energy delivered, is measured by means of a fluxmeter. The device, when calibrated against the time required for pulses to traverse various lengths of coaxial cable, gives a nearly linear response for times between 0.1 and 2.0 microseconds and reproducible response down to times of the order of 0.01 microsecond.

250 Naval Ordnance Laboratory.
AN INSTRUMENT FOR MEASURING THE IMPULSE AND GAS VOLUME OF PRIMER EXPLOSIONS, by G. U. Graff. NOLM report no. 10507. Unclassified report.

A test set for measuring the impulse and gas volume resulting from the explosions of primers is described and discussed. A study of functioning characteristics of the test set show it to be convenient to use, to give reproducible results and to give gas volume readings which are in good agreement with theoretical values. Work toward establishing a correlation between primer characteristics as indicated by values derived from gas volume and impulse tests and primer characteristics as indicated by values derived from other instruments show good general agreements, but no quantitative correlations have been established.

251 Naval Ordnance Laboratory.
TEST SET, MK 172, MOD 1, FOR OUTPUT COMPARISON OF PERCUSSION INITIATED FUZE PRIMERS, by C. J. Zablocki, J. A. Ayres, and F. W. Hayward. 8 December 1949. NOLM report no. 10658. Unclassified report.

The Test Set, Mk 172, Mod. 1, or Primer Ballistic Pendulum, is described in this report. The subject test set provides a means of comparing percussion fuze primers in terms of the momentum delivered to a ballistic pendulum by the reaction of the escaping combustion products. The combustion products are directed through an orifice in such a fashion as to produce a short duration thrust against the firing chamber which carried the primer. The firing chamber is an integral part of the ballistic pendulum system, therefore the throw of the ballistic pendulum is a measure of the "impulse", or time integral of the thrust. Typical test results are shown, as well as illustrations of the completed equipment.

252 Naval Ordnance Laboratory.
EVALUATION OF SYNTHETIC-SHEATHED DETONATING CORDS, by A. R. Timmins. April 27, 1951. NAVORD report 1771. Unclassified report.

The need for an improved detonating cord -- with better low-temperature properties, increased waterproofness, and greater resistance to abrasion -- led to the evaluation of various types of polyethylene - sheathed detonating cord. Tests performed included safety (shock, flame, bullet impact, and passage of a vehicle over the cord); low temperature; waterproofness; abrasion; breaking strength; detonation velocity (under normal conditions and after surveillance at 160°F); propagation sensitivity; and stiffness. Results showed all of the polyethylene-sheathed cords to be better than standard cord in some major respects. However, all but one type also had such shortcomings as: low breaking strength, high bullet impact sensitivity, and erratic performance. The cord which met all requirements consisted of an explosive core inside a braided seamless cotton tube covered with a layer of asphalt followed by a layer of rayon, all encased in a polythylene sheath.

Naval Ordnance Laboratory.

ANODIZING AND DYEING ALUMINUM DETONATOR DISCS AS MEANS OF IDENTIFYING THE SENSITIVE ENDS OF FLASH DETONATORS, by G. U. Graff and E. Metz. 26 June 1951. NAVORD report no. 1875. Project NOL-Re2b-41-1-51, problem 11. Unclassified report.

One part of Problem 11 under project NOL-Re2b-41-1-51 was to determine a means of coloring the sensitive end of Mk 54 detonators red without impairing their sensitivity. This was necessary because tests had shown that when coloring is effected by applying a film of red NRC compound (as is ordinarily done) the detonator sensitivity is reduced to the point where reliability of operation in the fuze is considerably lowered. Anodizing and dyeing was suggested as one method of obtaining the coloring that would, perhaps, not impair the sensitivity. A satisfactory method was developed for anodizing and dyeing 0.001 aluminum sheet. Detonators made with sensitive end discs punched from the anodized and dyed aluminum sheet were found to compare favorably in sensitivity with detonators made with uncolored discs.

Naval Ordnance Laboratory.

RECENT DEVELOPMENTS IN THE VACUUM THERMOCOUPLE TIMER, by R. Stresau and C. Goode. 28 June 1951. NAVORD report 2137. Unclassified report.

The timing circuit described in NOLM 10434 (which consists of two hydrogen thyratrons one of which starts and the other stops the flow through the heater of a vacuum thermocouple, of an electrical pulse of known amplitude and of duration equal to the time to be measured) was modified by substituting a 2021 argon-filled thyratron for the 3C45 hydrogen thyratrons used in the earlier circuit. The resulting circuit was satisfactory for the measurement of times greater than 1/2 microsecond. Amplifiers for the input signals were devised making the timer useful with signals as weak as 20 volts. A peak holding microvoltmeter was substituted for the fluxmeter, first as a separate unit, later as an integral part of the timer, which had several other convenient features. (reh)

Naval Ordnance Laboratory.

SENSITIVITY TEST OF PRIMERS AND DETONATORS USING TEST SET MK 135 MOD O (PRIMER) AND TEST SET MK 136 MOD O (DETONATOR). 1 July 1951. NAVORD OD 5823. Unclassified report.

Procedures are given for testing primers with Test Set MK 135 Mod O and for testing detonators with Test Set MK 136 Mod O. Appendixes briefly describe the run-down, probit, and staircase methods for determining sensitivity. Photos of the MK 135 Mod O and MK 136 Mod O test sets are included. (reh)

Naval Ordnance Laboratory.

LOW VELOCITY DETONATION OF CERTAIN PRIMARY EXPLOSIVES, by R. H. F. Stresau. 28 May 1952. NAVORD report no. 2460. Unclassified report.

The nature of the damage sustained by tubes in which the explosives were confined indicated that both lead azide and mercury fulminate, when pressed to rather high densities, reacted in a very different manner than when loaded at slightly lower densities. It was found that this different type of reaction was induced by initiation within a limited range of vigor. Measurements of propagation velocity gave three ranges for mercury fulminate 4,000 to 5,000 meters per second, 1,400 to 1,700 meters per second and a few inches per second. Only the two upper ranges were observed for lead azide. More vigorous initiation resulted in a greater tendency toward reactions in the higher velocity ranges. Further observation of the intermediate, 1,400 to 1,700 meters per second, velocity range of mercury fulminate showed no difference between the velocities obtained with 0.1 and 0.15 diameter columns nor did the velocity vary when measured over 1, 2 and 3 inch column lengths. An attempt to induce a reaction of this type in 0.2 diameter columns resulted only in reactions which propagated at velocities in the high range of 4,000 to 5,000 meters per second. Experiments with various confining media seemed to show some effect of confinement but the results were too scattered to be statistically significant. Several possible mechanisms of the reaction are discussed.

287 Naval Ordnance Laboratory.

STATISTICAL STUDY OF PRIMER SENSITIVITY DROP-TESTS, by J. R. Sullivan. 10 June 1953. NAVORD report no. 2226. Unclassified report.

A study was made of the validity of the method used in conducting primer and detonator drop-tests at the Naval Ordnance Laboratory. Details of primary interest were (1) arithmetic vs. logarithmic intervals, (b) variation in interval size, and (c) the effect of sample size on the accuracy of the results obtained.

Mk 101 type and Mk 102 type primers were subjected to sensitivity tests by the up-and-down (Bruceton) technique and the rundown technique. A detailed statistical analysis was conducted on the results of the sensitivity tests. The analysis showed that:

1. Where sample size permits and high accuracy of results is desired, the rundown technique with probit analysis should be used.

2. The lack of superiority of either arithmetically or logarithmically spaced intervals permits the use of whichever appears most appropriate for the particular test.

3. Whenever possible, when using the up-and-down (Bruceton) technique, tests using different interval sizes should be used to estimate the mean and standard deviation.

4. The up-and-down (Bruceton) technique should not be used to estimate points outside the 10% or 90% range.

5. Appropriate confidence intervals should be computed and furnished with all estimates.

6. Where erratic behavior is a primer characteristic, use of the up-and-down (Bruceton) technique is open to serious question.

288 Naval Ordnance Laboratory.

EVALUATION OF THE PRIMER MK 126 MOD O (REPLACEMENT FOR THE PRIMER CAP NO. 3, IMPROVED); by J. H. Herd. 22 July 1954. NAVORD report no. 3713. Unclassified report.

The percussion Primer Cap no. 3, Improved, limits the life of the detonators Mk 7 Mod 3, Mk 8 Mod 4 and Mk 53 Mod O in which it is used. As a result the Laboratory was requested to develop a primer having improved surveillance properties. The improved primer, experimentally designated XP-21A, contains the stable explosive mix, NOL Mix No. 60.

In the evaluation, the performance of the new primer was compared with that of the Primer Cap. The XP-21A was found to be more sensitive and remained so through temperature and humidity conditioning. Initially the output of the Primer Cap exceeded that of the XP-21A; however, within 14 days of temperature and humidity cycling, the reverse was true. Low order initiations of the Primer Cap occurred after 28 days of surveillance conditioning and failures occurred after 71 days of conditioning. The 211 day withdrawal sample contained 100% failures. No low order initiations or failures of the XP-21A occurred through 246 days of the conditioning. The lag times of the XP-21A were significantly shorter than those of the Primer Cap, but this was not considered of major importance in the application.

Because of the superiority of the experimental primer over the primer cap, the XP-21A was recommended for release to production, as the Primer Mk 126 Mod O, to replace the primer cap in all applications.

289 Naval Ordnance Laboratory.

A STUDY OF THE EFFECTS OF STATIC ELECTRICITY ON LOW INPUT ENERGY ELECTRIC INITIATORS OF THE CARBON BRIDGE TYPE, J. N. Ayres. 5 August 1954. NAVORD report no. 3670. Unclassified report.

At various ordnance installations, a number of accidents with carbon-bridge electric initiators have been noted. A study of these accidents plus experimentation at the Naval Ordnance Laboratory demonstrate that this type of electric initiator is extremely susceptible to initiation by the electrostatic discharges. Initiations have been caused under the following conditions of application of potential differences to the initiator structure, lead-to-lead, lead-to-case, leads-to-case, and to center of leads with lead ends and case electrically shorted. It has been found that some operator grounding systems such as dangling chains, conductive shoes, and wrist bands are sometimes ineffective. It has been found that an ungrounded operator can accumulate an electrostatic charge not only by friction processes, but also by capacitive induction. It is felt that electric initiators can be handled safely, or at least with minimum risk, by the application of a few basic principles. The principles are not here abstracted since any abridgment could lead to misinterpretation.

260 Naval Ordnance Laboratory.

ELECTRICAL PERFORMANCE CHARACTERISTICS OF THE MK 57 MOD 1 DETONATOR; by Bernard Bernstein. 8 November 1954. NAVORD report no. 3899. Unclassified report.

Comprehensive testing of the firing characteristics of the Detonator Mk 57 Mod 1 yielded the following results:

1. With a constant current source, the detonator will fire on a minimum potential of about 3 volts.

2. The constant current firing requirement is about 150 to 250 milliamperes for 0 and 100% firing respectively.

3. When fired by a condenser charged to 27.6 volts, the 50% firing energy was 14,242 ergs, while the average firing time was 22.5 microseconds. Lower voltages require higher energies and longer firing times.

261 Naval Ordnance Laboratory

APPLICATION OF THE STEEL PLATE DENT TEST TO THE QUALITY CONTROL OF THE MK 63 DETONATOR; by W. M. Slie and R. H. Stresau. 3 December 1954. NAVORD report no. 3879. Unclassified report.

The output of a number of different production samples of the Mark 63 detonator was measured in a dent test under several conditions of external confinement. The results indicated that the small scale plate dent test can be used as a measure of output quality control for the Mark 63 detonator.

262 Naval Ordnance Laboratory.

EFFECT OF HARDNESS OF THE STEEL USED UPON THE RESULTS OF THE STEEL DENT TEST OF DETONATORS, by L. D. Hampton. 10 May 1955. NAVORD report no. 3983. Unclassified report.

A study was made of the depth of dent produced in different samples of steel by several different detonators in order to determine what effect, if any, the variation in the hardness of the steel would have upon the depth of the dent produced by the detonator. The results indicate that this effect is negligible if the hardness of the steel is reasonably uniform. It is indicated that this uniformity can be obtained by specifying the use of SAE 1020 steel for the steel dent test of detonators.

263 Naval Ordnance Laboratory.

EVALUATION OF THE DETONATORS MK 58 MOD O AND MK 65 MOD O AND THE PRIMER MK 105 MOD 1, WHICH REPLACE COMPONENTS CONTAINING MERCURY FULMINATE; by J. H. Herd and W. C. Pickler. 8 July 1955. NAVORD report no. 3971. Unclassified report.

To complete the removal of mercury fulminate explosives from naval ordnance, a task was established to investigate the replacement with components containing improved explosive mixes. The components affected are the Frimer Mk 105 Mod O; Detonator Mk 20 Mod O and the Detonator Mk 30 Mod O. To improve the surveillance properties of these components, the mercury fulminate mix in the Mk 105 Mod O was replaced by a stable mix designated NOL mix No. 60, the mercury fulminate in the Mk 39 was replaced by lead azide, and that in the Mk 20 was replaced by NOL Frimer Mix No. 130 and lead azide. The new primer has been designated Mk 105 Mod 1. The detonators replacing the Mk 20 Mod O and the Mk 39 Mod O have been designated the Mk 65 Mod O and Mk 58 Mod O, respectively.

The evaluation was essentially a determination that the replacement would not detrimentally affect the static firing train reliability and/or detonator safety of the fuzes in which the components are used. These are the Fuzes Mk 221, 223, 228, 230, 243 and 244. A number of Fuzes Mk 228, 230 and 244 loaded with the improved components were subjected to the reliability and safety tests. It was felt that these three fuzes are representative of the list above. The testing indicated that the static firing train reliability and detonator safety of the fuzes containing the new components are adequate.

The evaluation also included testing of the components outside of the fuzes. No comparison of performances was made with the mercury fulminate components being replaced. It was felt that experience with mercury fulminate mixes and the mixes in the new components has indicated the superiority of the latter.

Since the performance of the improved components in the fuzes and affected delay elements was satisfactory, the Laboratory recommended that the new components replace the old in all applications.

204 Naval Ordnance Laboratory.

THE DEVELOPMENT OF A QUALITY CONTROL TEST FOR THE OUTPUT OF THE MK 130 MOD O PRIMER AND INPUT ENERGY REQUIREMENTS FOR THIS PRIMER, by B. Bernstein and B. B. Herman. 24 August 1955. NAVORD report no. 4228. Confidential report.

The input energy requirements for the Primer Mk 130 Mod O were determined by two different methods and a test set for quality control of the output of the above primer was developed. One method used for the determination of the input requirements was a constant current firing circuit. The calculated values for the O and 100% firing points were 220 and 300 milliamperes respectively. The second method employed a capacitor discharge. The 50% firing energy was 13, 830 ergs when fired by a condenser charged to 28 volts.

The apparatus developed for measuring the primer's output was essentially a gas burette attached through a manifold (glass) to a bomb in which the primer was fired. When properly used, the above apparatus can detect varying amount of black powder base charge to an accuracy of two (2) milligrams.

205 Naval Ordnance Laboratory.

DELAY ELEMENT MK 1 MOD O RESULTS OF 8-3/4 YEARS' STORAGE, by K. N. Boley. 5 October 1955. NAVORD report no. 4114. Unclassified report.

Timing tests extending over a period of 8-3/4 years have been completed on samples of the delay element Mk 1 MOD O. Firings during the first 3-1/2 years were conducted on samples which were stored unpackaged in an unheated magazine. Samples fired during the last 5-1/4 years were stored since their manufacture in hermetically sealed cans in an unheated magazine. Results indicate excellent reliability and little change in delay time as a consequence of this type of storage. Occasional long delay periods have been found to be caused by puncturing of the primer cups. Unreliable performance was observed at temperatures in the vicinity of 30°F and lower.

206 Naval Ordnance Laboratory.

EVALUATION OF THE DETONATOR MK 46 MOD 1; by J. H. Herd. 21 November 1955. NAVORD report no. 4157. Unclassified report.

The Hercules Powder Company recommended changes be made in the drawings of the Detonator Mk 46 Mod O. NOL approval was given with the understanding that the Laboratory would receive a preliminary lot sample for acceptance testing. Some of the major changes recommended were: including the detonator collar as part of the complete assembly, crimping the portion of the lead wire that is molded into a bakelite plug, sealing with stypol in place of a crimp seal, and redesigning of the plug.

Since the recommended changes were more likely to affect the detonator ruggedness and lead wire insulation than output or input characteristics, more emphasis was placed on rough handling tests than is usual in acceptance testing. The acceptance tests included sand bomb output tests, insulation tests and extreme rough handling tests. On the basis of the results found, the preliminary lot submitted was considered acceptable. The Laboratory recommended that the modified detonator, which was designated Mk 46 Mod 1, replace the Detonator Mk 46 Mod O in all applications.

207 Naval Ordnance Laboratory.

AN IMPROVED METHOD FOR THE ASSAY OF LEAD AZIDE, by S. G. Landsman and J. M. Rosen. 15 December 1955. NAVORD report 4191. Unclassified report.

An improved method of assaying lead azide containing dextrin or polyvinyl alcohol is based on the quantitative distillation of the volatile hydrazoic acid produced in the reaction between lead azide and dilute sulfuric acid. The hydrazoic acid is collected in a receiver containing a measured quantity of ceric oxidant with which it reacts to produce nitrogen as follows:

$$2\ N_3^- + 2\ Ce(IV) \longrightarrow 3\ N_2 + 2\ Ce(III).$$

Excess cerate is determined by a titration using a standardized sodium oxalate solution.

Dextrin or other non-volatile organic substances in lead azide do not interfere with the distillation procedure whereas they produce high assays in the Navy specification method of analysis.

268 Naval Ordnance Test Station.
THE DEVELOPMENT OF THE SQUIB Mk 1 FOR USE IN NAVY ROCKET IGNITERS, by R. L. Smith. 6 April 1956. NOTS report no. 1384. NAVORD report no. 5039. Unclassified report.

The squib Mk 1 was developed in response to the need in Naval ordnance for a high-quality squib to initiate small metal-cased igniters. The first fully specified, non-proprietary Navy squib, the Squib Mk 1 overcomes the deficiencies of earlier squibs in reliability, safety, and quality control. The results of proof testing in 2.75-in. folding-fin aircraft rocket igniters and motors were entirely satisfactory. Of more than 12,000 squibs produced, none have been rejected.

269 Naval Ordnance Laboratory
THE EFFECT OF EXPLOSIONS IN PLASTICS, by H.A. Perry, Jr., 28 May 1956. NAVORD Report No. 4308. Unclassified report.

Twelve plastics of various types were moulded in conical form and subjected to shocks generated by charges of lead azide detonated on their bases. Charge weights and specimen temperatures were varied. Ethyl cellulose showed outstanding resistance to fracture and flow, and transmissivity to shock waves. Polyethylene showed extensive plastic flow and energy absorption, particularly at 160°F. Rigid polystyrene flowed at elevated temperature; polymethyl methacrylate remained brittle. Polyesters shattered more extensively than other materials. Fibrous fillers aided in holding shattered specimens together.

270 Naval Ordnance Laboratory
DEVELOPMENT OF SWITCH, EXPLOSIVE MK 35 MOD 0, by D. T. Horton and A. B. Leaman. 15 June 1956. NAVORD report no. 4255. Unclassified report.

The Switch, Explosive, Mk 35 Mod O was designed to execute the action of an electrical relay, without the inherent tendency of relays to open, close or chatter during shock or vibration.

The switch is essentially an explosive relay with one normally closed circuit and one normally open, relatively high current capacity circuit. It has passed the various rigid test requirements outlined for the development of ordnance and in addition it has an operating temperature range of -65°F to + 160°F.

The reliability of operation, based on design tests and acceptance tests for production lots, has been above 98%. A more extensive evaluation of switches from production lots is being carried out.

271 Naval Ordnance Laboratory.
AN INTENSIVE SUBSTITUTE FOR GRAPHITE BRIDGE DETONATORS FOR LABORATORY EVALUATION OF FUZE EXPLOSIVE TRAINS, by W. M. Slie. 6 February 1957. Project no. 301-664/43006/12040. Unclassified report. NAVORD report no. 4512.

A technique for producing desensitized substitutes for carbon bridge detonators is reported. These substitutes are useful in explosive train evaluation work. Desensitized Mk-63 AND T-79 detonators were produced, and their sensitivity is compared with that of a commercial blasting cap. From Bruceton tests the minimum firing energies for the desensitized Mk-63 and the standard Mk-63 were obtained and compared.

272 Naval Ordnance Laboratory.
EVALUATION TEST RESULTS ON SERVICE AND EXPERIMENTAL SQUIBS, by G. W. Peet and L. F. Gowen. 4 March 1958. NAVORD report 4061. Unclassified report.

A study was made to determine the performance characteristics of several widely used squibs. The eight squibs tested include the M1A1, S-67, S-68, D-55, Mk 1, Mk 114, XE-8A and XE-8B. The squibs were subjected to direct current, condenser discharge, and electrostatic sensitivity tests; direct current and condenser discharge functioning time tests; and environmental conditioning tests.

Squibs least sensitive to direct current and condenser discharge energy were the S-68, S-67 and XE-8B; the three most sensitive squibs were the XE-8A, Mk 114 and Mk 1.

The XE-8A, Mk 114, Mk 1 and M1A1 squibs were quite sensitive to the discharge of electrostatic energy, all of which fired on 50,000 ergs or less.

When fired with a direct current of 5.0 amperes, all squibs but the S-67 functioned in less than 5 milliseconds; the Mk 114, XE-8A and Mk 1 squibs all functioned in less than 1 millisecond.

When fired with the 4 mfd condenser discharge system with a charging voltage of 100 volts, the Mk 1, Mk 114, XE-8A and XE-8B squibs all functioned in less than 0.1 millisecond; all the other squibs tested gave functioning times from 1 to 14 milliseconds.

The Mk 1 and XE-8B (not a service item) squibs yielded generally satisfactory results for the sensitivity and functioning time tests, and, in addition, were the only two squibs which essentially retained their original properties after environmental conditioning.

273 Naval Ordnance Laboratory.
HIGH TEMPERATURE EFFECTS ON THE XE-27A PRIMER AND T79 DETONATOR, by H. Leopold. 15 March 1958. NAVORD report no. 6083. Project 507-525/53022/14040. Unclassified report.

An exploratory study has been carried out to determine the effect of elevated temperatures on electroexplosive initiators. This study indicates that the carbon bridge is the most heat susceptible part of the XE-27A primer and T79 detonator. The carbon bridge failed in the 160 to 170°C range. The T79 detonator will explode (cook off) at temperatures at least as low as 183°C in a heating time of approximately 3-1/2 minutes. The XE-27A primer, which contains less PETN than the T79 detonator, will explode (cook off) at temperatures at least as low as 195°C in a heating time of approximately 3-1/2 minutes.

274 Naval Ordnance Laboratory.
A COMPARATIVE STUDY OF FIRE PYROTECHNIC DELAY COMPOSITIONS, by M. F. Murphy. 2 April 1958. NAVORD report no. 5671. Unclassified report.

Five types of gasless delay powders and three gasless igniter compositions were investigated for performance at -54°, 25° and 71°C and after low and high humidity surveillance at 71°C. These powders are presently specified for loading in the fuze explosive trains of ordnance devices in use by the Army and Navy. Some differences were found in the characteristics of both delay and igniter powders, particularly at low temperatures and after high humidity surveillance. A detailed study was made of manganese delay compositions in two test sets. A determination was made of the importance of particle size and the chemical inactivation treatment of manganese gasless delay fuels.

275 Naval Ordnance Laboratory.
DEVELOPMENT OF THE XE-69A PRIMER, by H. S. Leopold. 10 April 1958. NAVORD report no. 6089. Unclassified report.

An electrically initiated primer has been developed for the Demolition Firing Device XN-4A. This primer is capable of firing a non-electric Engineers Special blasting cap across a 1.42 inch air gap and through a 0.001 inch aluminum barrier.

The primer has a bridge resistance in the range of 10 to 16 ohms and a 99.99 percent probability of firing with 3690 ergs at 50 volts. The primer will function and fire the non-electric Engineers Special blasting cap over a -65 to ± 160°F temperature range. Standard environmental tests have been conducted on this primer and in all cases it performed satisfactorily after testing. The output of the primer as measured in the sand bomb test is 4.43 grams.

276 Naval Ordnance Laboratory.
PRIMERS XE-66A, XE-67A, XE-70A FOR HOTPOINT, by V. J. Menichelli. 8 May 1958. NAVORD report no. 6088. Unclassified report.

Delay primers XE-66A, XE-67A and XE-70A have been developed for the Hotpoint program. They are basically identical in design, with the exception that the length of the delay column varies to give the desired delay times. The delay times for the primers are nominal 0.3, 0.6, and 1.0 second, respectively. The primers have been subjected to limited testing, including functioning and delay times over the temperature range -65 to 160° F, transfer of initiation between the primer XE-67A and an explosive capsule which the primer initiates in its end item application, output testing, and surveillance studies. Satisfactory performance was obtained in all tests with the exception of MIL STD 304 of the surveillance studies.

277 Naval Ordnance Laboratory.
THE DEVELOPMENT OF THE XE-16A ACTUATOR, EXPLOSIVE AS A REPLACEMENT FOR THE MK 1-MOD 0 ACTUATOR, EXPLOSIVE, by E. E. Kilmer and M. J. Falbo. 26 May 1958. NAVORD report no. 6111. Project NOL-C7c-278-1-54. Unclassified report.

An actuator, designated XE-16A, has been developed to replace the Mk 1 mod 0 actuator in the Mk 52 drill mine. Better surveillance characteristics have been obtained by using unique powder as a substitute for the black powder formerly used as the base charge. Milled normal lead styphnate has been substituted for DDNP-potassium chlorate mix as the ignition charge. Several design changes to increase ruggedness were also made. Laboratory and field tests indicated that the XE-16A actuator would be a satisfactory actuator in the Mk 52 drill mine.

278 Naval Ordnance Laboratory.
AN EVALUATION OF THE DU PONT S-68 SQUIB (U), by R. B. Houghton. 26 November 1958. NAVORD report no. 6224. Unclassified report.

The du Pont electric Squib S-68 was subjected to rough handling and surveillance tests to determine its characteristics under adverse conditions. Capacitor discharge in-put tests conducted on the squib showed that the rough handling tests had no effect on sensitivity, and temperature and humidity conditioning apparently decreased the sensitivity. It was later found that the squib's bridge wire mixture reacted with the carbon dioxide atmosphere in the test chamber. A third test of the squib in a mechanical temperature cycling chamber proved the squib could withstand adverse temperature and humidity with no decrease in sensitivity.

279 Naval Ordnance Laboratory.
DEVELOPMENT OF IGNITION ELEMENTS FOR GUIDED MISSILE IGNITION SYSTEMS, by G. W. Feet, E. E. Elzufon, and L. F. Gowen. 5 March 1959. NAVORD report no. 6283. Unclassified report.

The use of commercial and military service squibs proved to be unsatisfactory for achieving reliable ignition when used in many of the newly developed guided missile ignition systems. The Mks 1, 2, 3, and 4 ignition elements, originally designed for Navy gun primers, were first used by the Allegany Ballistics Laboratory in an attempt to supplant squibs in guided missile ignition systems. The use of these elements lead to the development of the Mk 5, 6, and 7 ignition elements which were designed specifically for guided missile ignition systems.

The Mks 5, 6 and 7 ignition elements were subjected to sensitivity tests, output tests, and direct current functioning time tests under various conditions. All three of the ignition elements produced satisfactory test results when subjected to the given tests.

280 Naval Ordnance Laboratory.
EFFECTS OF ELEVATED TEMPERATURES ON ELECTRICAL INITIATORS AND COMPONENT PARTS, by H. S. Leopold. 1 April 1959. NAVORD report 6267. Unclassified report.

A study has been made of the effects of elevated temperatures on the XE-56A actuator, XE-54B primer, XE-57A primer, XE-69A primer, Mk 115 mod O primer, and the Mk 121 mod O primer, and on their inert component parts. It has been found that graphite bridges and bridges attached to bakelite initiator plugs by the spray metal method have poor thermal resistance. Ceramic initiator plugs with the bridge wire swaged into welded nickel tabs, and glass kovar initiator plugs with the bridge wire soldered with lead (m. p. 621°F) have good thermal resistance.

281 Naval Ordnance Laboratory.
EVALUATION OF EXPLOSIVE SWITCHES, MK 66 MOD O AND MK 67 MOD O (U), by C. E. Baughn. 1 May 1959. NAVORD report 6628. Unclassified report.

Explosive switches Mk 66 mod O and Mk 67 mod O are used in ordnance systems developed at the Naval Ordnance Laboratory. Mk 66 mod O has no delay and the Mk 67 mod O contains a three second delay column. Inspection revealed all units to be conformant to the manufacturer's specifications. Results also showed that temperature and humidity cycling affected the Mk 66 switches adversely. Cold temperature (-65°F) affected functioning of the Mk 67 switch, as did dry temperature storage at +160°F. Vibration and shock did not appear to affect performance of these switches. Switch chatter was prominent on most all of the switches tested.

282 Naval Ordnance Laboratory.
DEVELOPMENT OF THE WOX-1A SQUIB (U), by V. J. Menichelli. 25 May 1959. NAVORD report no. 6304. Unclassified report.

A hermetically sealed, electrically initiated squib, the WOX-1A, has been developed for use in the SUBROC missile. The purpose of the squib is to initiate a propellant capsule over a 0.200-inch air gap in the WOX-7A igniter. The squib is 0.350-inch long and 0.273 inch in diameter. Its bridge resistance is between 1.0 and 1.9 ohms. The energy for 0.999 probability of firing by capacitor discharge at 60 volts is estimated as 73,000 ergs. The squib has been subjected to the standard Navy environmental and surveillance tests. Output and safety tests in the igniter were also conducted. Satisfactory performance was obtained in all tests.

283 Naval Ordnance Laboratory.

THE BEHAVIOR OF SEVERAL WIRE BRIDGE INITIATORS SUBJECTED TO ELEVATED TEMPERATURES (U), by J. J. Montesi. 15 June 1959. NAVORD report no. 6667. Unclassified report.

The effect of high temperatures on the characteristics of several electric initiators was determined. The temperature were those likely to occur in missiles at the detonator site as a result of aerodynamic heating. The characteristics of interest were cook-off, functioning, and output. The initiators studied were the primer Mk 140-0 and the detonators Mk 70-0 and Mk 71-0.

284 Naval Ordnance Laboratory.

EVALUATION OF THE EXPLOSIVE ACTUATOR XE-16A (U), by R. B. Houghton. 5 August 1959. NAVORD report 6696. Unclassified report.

The explosive actuator XE-16A is an electric actuator designed for use in low pressure applications in explosive release mechanisms. The actuator was subjected to rough handling and surveillance tests. Results show no apparent effect on sensitivity or output.

Partial burning of the powder occurred in 15% of all firings. These partial burnings were not a function of environmental conditioning nor of applied electrical initiation energy. In two field tests the actuator had an excessively high burning rate. It appears that the burning rate is dependent upon the powder confinement. (vis)

285 Naval Ordnance Laboratory.

THE HARMONIC GENERATION TECHNIQUE FOR THE DETERMINATION OF THERMAL CHARACTERISTICS OF WIRE BRIDGES USED IN ELECTRO-EXPLOSIVE DEVICES (U, by L. A Rosenthal. 9 September 1959. NAVORD report 6691. Unclassified report.

The thermal equations for a wire bridge or equivalent electro-explosive device are presented. When a sinusoidal current passes through such a thermally sensitive resistance, it is capable of generating a third harmonic voltage which is a measure of the resistance's ability to follow the instantaneous cycling power fluctuations. By measuring the variation of this third harmonic with frequency it is possible to determine the thermal time constant with good accuracy. The heat equations are also verified. Confirming experimental data are presented.

286 Naval Ordnance Test Station.

AN IGNITER FIRING - DELAY INDICATOR, by A.G. DeBell. 24 March 1948. NAVORD report no. 1009. NOTS REPORT no. 125. Unclassified report.

Equipment was designed and constructed for measuring the time delay between the initiation of the equib current and the bursting of the igniter case used in rocket ordnance. The equipment is semiportable and can be operated easily by unskilled personnel. The time delay is indicated to the nearest 0.1 millisec and the data are available immediately after firing.

287 Naval Ordnance Test Station.

EXPLOSION RATES OF SOME LEAD AZIDE MIXTURES, by H. P. Jenkins, Jr. and C. H. Shomate. 28 September 1950. NAVORD report no. 1260. NOTS report no. 325. Unclassified report.

It was observed that the progress of the decomposition of lead azide could be controlled over wide limits by intimate mixing and consolidating of the azide grains with aluminum stearate or stearic acid. The time of propagation of an explosion through a 0.9-inch long column of azide so treated was from 300 to 900 microseconds, depending upon the amount and nature of the waxy diluent, whereas the corresponding time for a column of untreated azide was about 10 microseconds. With other diluents such as salt, graphite or metallic powders, the time of propagation of the explosion was increased only slightly, if at all.

A primary explosive, so treated with a waxy material, might be used as a delay element in the firing train of a fuze.

288 Naval Ordnance Test Station.

DEVELOPMENT AND DESIGN OF DELAY TESTER NOTS MODEL 8, by R. G. Gaumer. For period 1 December 1952 - 1 September 1953. NOTS technical memorandum no. 1510. Task assignment NOTS Re 2b-11-1. Unclassified report.

The desirable features of an existing experimental model of a tester to determine the sensitivity to impact of percussion-initiated delay elements were incorporated in the Delay Tester NOTS Model 8. The unique feature of the original model was that the energy used to fire the delay was obtained from a spring to which a dead-weight load was attached for purposes of calibration; this feature of the design was retained. Although the original model was workable, it was also slow, difficult and expensive to operate. These faults were eliminated in the improved design of Delay Tester NOTS Model 8, which has functioned in a satisfactory manner and is considered to be ready for testing on the production line. The new tester could be adapted readily to other types of delay elements.

289 Naval Ordnance Test Station.

AN INFRARED SPECTROPHOTOMETRIC DETERMINATION OF NITROSTARCH IN XC-9 INITIATION MIXTURE, by A. N. Fletcher. 23 July 1957. NOTS report no. 1780. NAVORD report no. 5580. Unclassified report.

An infrared spectrophotometric method has been developed for the determination of nitrostarch in the supernatent liquid of XC-9 initiation mixture. The liquid sample is filtered and evaporated to dryness. Acetone is added and the absorbance at 11.8 u is determined. An iterative or a quadratic method is used to calculate the amount of nitrostarch present.

The precision is reflected by a percent coefficient of variation of 0.4. The accuracy is calculated to be within ± 4.5% of the amount present for a nominal composition of 2.72 g of nitrostarch per 100 g of solvent.

290 Naval Ordnance Test Station.

STUDY OF EXPLOSIVE SENSITIVITY OF COBALT AMINE COMPLEXES, by T. B. Joyner. 14 October 1957. NAVORD report no. 5639. NOTS report no. 1864. Unclassified report.

The impact sensitivity of a number of cobalt ammines containing oxidizing anions or azide ions in either coordinated or ionic positions has been measured. An attempt was made to ascertain if any single property of the compounds is the determining factor in establishing the sensitivity. No systematic variation in sensitivity is noted when the nitrite or nitrate ions are progressively substituted for coordinated ammonia, nor can it be determined with certainty whether the ignition of these compounds and other salts of the dinitro substituted complexes is initiated by the coordinated or ionic anion. Uniform sensitivities are noted for salts of permanganate, perchlorate, chlorate, and bromate ions when the anion is restricted to an ionic, uncoordinated position. A consideration of the nature of the ignition process suggests that the relative sensitivities of these compounds may be determined by the activation energy of the reaction of the anion with the coordinated ammine. Preliminary data on several compounds containing azide ions are also reported.

291 Naval Ordnance Test Station.

NOTS STANDARD METHOD FOR ANALYSIS OF FLASH SIGNAL COMPOSITION NOTS-XS-157, by R. H. Pierson. 8 January 1959. NAVORD report no. 6440. NOTS report no. TP 2147. Unclassified report.

A minimum-effort wet-method analysis was developed for the analysis of a flash signal mixture containing barium nitrate, aluminum powder and calcium stearate. The barium nitrate is determined from the loss in weight of a sample when it is extracted with cold water. Calcium stearate is calculated from a determination of the stearic acid liberated by treatment of a sample of the flash powder with hydrochloric acid and methanol. Aluminum is calculated by difference. A method for incidental moisture is also provided.

292 Naval Powder Factory.

METHODS OF OPENING DETONATORS AND PRIMERS, by R. F. Brawner and R. Miller. August 28, 1946. Technical report no. 12. Unclassified report.

Describes methods and instruments used by the Naval Powder Factory for opening detonators and primers. The machines and instruments required are illustrated by photographs and drawings. (ama)

293 Naval Propellant Plant.

A RAMP-TYPE TESTING CIRCUIT FOR ELECTRIC EXPLOSIVE DEVICES, by A. H. Klein and T. D. Phillips. 3 November 1958. Memorandum report no. MR 155. Task assignment no. 506-925/56015/08058, "Hazards of Electromagnetic Radiation to Ordnance (HERO)." Unclassified report.

A circuit has been designed for the determination of the relative sensitivity to electrical initiation of a squib or ignition element in comparison to similar squibs or ignition elements. In this circuit, the squib or other electric explosive device is fired by sending through its bridge wire a current which increases with time along an established curve. The position on the current-time curve at which firing occurs is the datum observed. The circuit is particularly useful in experimental work in which the items to be tested cannot be produced in sufficient quantity to supply a test of the "fire-or-fail" type.

294 Naval Proving Ground.

SAFE CONTAINERS FOR TRANSPORTING BLASTING CAPS IN VEHICLES, by V. Philipchuk. September 30, 1953. NPG report no. 1183. Final report on safe containers for transporting blasting caps in vehicles. Unclassified report.

An investigation was conducted to design, test, and evaluate safe containers for special engineers' blasting caps. A 4.45-in.-od steel tube with a 0.215-in. thick wall and 3/4-in.-thick end covers was considered satisfactory for transporting 24 non-electric caps with a 6-in. tube length or 12 electric caps with a 12-in. tube length. It is concluded that the containers will not rupture or throw fragments under the most adverse conditions. Adoption of these containers for use in ammunition vehicles transporting blasting caps with other ordnance is recommended.

295 Naval Radiological Defense Laboratory, San Francisco Naval Shipyard.
USE OF PRIMACORD AS A ZIPPER, by R. I. Condit and D. B. Moore. 2 November 1950. Memorandum report. Technical objective SR-2a. Unclassified report.

This brief report deals with the use of Primacord as a "zipper" for the remote-control removal of covers from measuring and indicating equipment. The primacord is stitched through the cover material, fastened to it, or run through a hem in it (like a drawstring).

To prevent pitting of the equipment from the explosions of the Primacord and the blasting caps used to initiate it, an auxiliary framework of iron rather than wood should be used. The explosion of the cord will groove the latter to a depth of 1/4 to 1/2 inch. (rh)

296 Naval Research Laboratory.
STATIC ELECTRIFICATION OF STEEL CARTRIDGE CASINGS WITH DIELECTRIC COATINGS AND THE MK47 ELECTRIC PRIMER, by K. W. Bewig. October 18, 1957. NRL report 5026. NRL problem C02-07. Project No. 804-188-81002-09-135. Project No. 804-188-81002-08-135.

The question has been raised about the possible hazard from the detonation of electric primers caused by free electrostatic charges residing on cartridge casings. Steel cartridge casings, in particular, are being coated with dry lubricating epoxy phenolic resin and Teflon films which also serve as a protection against corrosion. For several different methods of handling it is shown that, in a dry atmosphere of 11 percent relative humidity, the total induced charge on 50 or more cartridge casings would have to be collected on a single reservoir and discharged under favorable circumstances through an MK47 electric primer in order to cause accidental detonation. In an atmosphere of 55 percent relative humidity, this number increases to more than 375 cartridge casings.

The highest value of charge obtained on a single casing with an epoxy phenolic resin was 7.9 esu; the comparable figure for a Teflon film was 24.8 esu. These values are to be compared with a charge of 1200 esu at a potential of 1000 volts required to detonate the MK47 electric primer 100 percent of the time.

297 Naval Weapons Laboratory.
A METHOD FOR PROTECTING ELECTROEXPLOSIVE DEVICES FROM SPURIOUS ELECTRICAL INITIATION, by R. R. Potter. February 1960. Technical memorandum report no. W-3/60. Unclassified report.

Describes a means of protecting an electroexplosive device from spurious electrical initiation by inclosing it in a metallic shield. A series connected silicon diode allows a large direct current to melt the shield at the firing leads without initiating the device. A direct current of opposite polarity or an alternating current is then used for firing.

Experimental results and derivation of design formulas are included. (mw)

298 Narvarte, J. E.
BLASTING CAP. June 5, 1945. U. S. Patent no. 2,377,804.

An electric blasting cap, said cap including a conducting shell containing a primer charge, a bridge wire embedded in said primer charge and conducting leads connected by said bridge wire, insulating sealing means for said shell in which said leads are laid, and means forming with the shell wall a sealed chamber containing an ionizable gas affording high resistance path between each of said leads and said shell from points on said leads spaced substantially from said primer charge, the resistance of said paths being such as to permit discharge therethrough of electrostatic charges on said leads or shell which establish a high potential difference therebetween, but being appreciably lower than that afforded between said leads and said shell at points adjacent said primer charge, whereby detonation of the cap by electrostatic discharge is precluded.

299 New York University.
INORGANIC PERCHLORATES, by N. Jacobson and M. Cinnamon. August 31, 1959. Yearly summary report for June 1, 1959 to May 30, 1959. Navy contract no. ONR 285 (36). Unclassified report.

Outlines the synthesis of aluminum and boron perchlorates. To date, neither of these compounds can be prepared at 100% purity. The maximum purity obtained for $Al(ClO_4)_3$ is 80%, while $B(ClO_4)_3$ can not be analized due to spontaneous decomposition on handling or drying.

The major impurities in $Al(ClO_4)_3$ samples are the result of solvent participation in the reaction. Methanol, nitromethane, benzene, ether and n-hexane are unsuitable solvents because of their reactivity. At present, inert solvents such as, perfluorohydrocarbons, are being investigated. (vis)

300 Noddack, W. and E. Grosch.

"Measurement of the detonation pressures of initiator-type explosives." In EXPLOSIVSTOFFE, v. 4, no. 4. April 1956. Picatinny Arsenal translation no. 9. Translated by G. R. Loehr. Unclassified report.

Pressure during deflagration and detonation of several sensitive (initiator-type) explosives was measured with piezoelectric measuring apparatus in a closed bomb and also in the open air. From the data obtained, conclusions as to output of pressure and energy were drawn.

The dependence of shock pressure on the distance between the explosive and the recording apparatus was also investigated, and the pressure of detonation at the surface of the explosive was calculated.

301 Noddin, G. A.

ELECTRIC INITIATOR. April 5, 1938. U. S. Patent no. 2, 112, 974.

A delay electric squib comprising a ventless metal shell, a deflagrating base charge, a localized charge of detonating explosive composition sufficient to perforate said shell and juxtaposed against the inner wall of the shell at a locus vicinal to the region thereof wherein said base charge is contained, a delay element, and means for electrically igniting said delay element.

302 Noddin, G. A.

INITIATOR. August 2, 1938. U. S. Patent no. 2, 125, 356.

A blasting initiator comprising an explosive charge enclosed in a shell of anodically treated aluminum.

303 Olin Mathieson Chemical Corporation.

REDESIGN AND IMPROVEMENT OF DETONATORS, DELAY 8 SECOND AND DETONATOR, DELAY 15 SECOND, by R. F. Ostmann. January 5, 1957. Monthly progress reports nos. 1-10 and final report. For the period January 15, 1953 thru September 15, 1956. ORD project no. TQ3-5306. Army contract no. DAI-23-072-ORD-(P)-15. Unclassified reports.

Self-contained, lightweight, non-metallic delay detonators (8- and 15-second) developed. Required to be watertight, safe to handle, protected from premature firing, and non-detectable by standard mine detectors. About 6-1/2 inches long, 11/16 inch in diameter, new design consisted of a ceramic delay tube ignited by pulling nylon striker through flash compound and a detonator containing 13-1/2 grains cyclonite. Outer parts made of fiberglass-reinforced polyester and detonator shell and flash receptacle made of mineral 70/30 zirconium/nickel plus barium chromate and potassium chlorate chosen as delay mix when mixture first tried (70/30 zirconium/nickel with barium nitrate) burned too hot and "popped" when 1/2 burnt. Barium-boron used as igniter mix. Delay mix loaded at 25,000 psi for more uniform delays and better rough handling characteristics. (rehl).

304 Ordnance Missile Laboratories. Redstone Arsenal.

COMPILATION OF DATA ON ARMY, NAVY, AND COMMERCIAL STANDARD ELECTRIC SQUIBS; by R. E. Betts. 20 January 1956. Report no. 3JI4N1. Project no. TU2-2S, phase II. Unclassified report.

This report is a revision of Redstone Arsenal Report S-1-a by Charles F. Quarles, dated 13 October 1950. The report is a compilation of data on Army, Navy, and selected commerical squibs that are of interest in the ignition of solid propellants.

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305 P. E. C. Corporation.

LITERATURE REVIEW AND GENERAL THEORETICAL WORK RELATED TO THE METAL AZIDES, n.d. Second quarterly technical report and final report. For the period 6 June 1958 to 6 July 1959. Army contract no. DA-44-009-ENG-3628. Army project no. 8-07-02-004. Final report supercedes all but 2nd quarterly report.

A theoretical study of the crystalline and electronic structures of the azide ion, based principally on a review of the open literature for the last thirty years, plus many classified and unclassified reports supplied to the contractor by Fort Belvoir. Discussed are the following: chemistry of explosives, crystallography of the azides, electronic structure of the azide radical and the azide ion, magnetic resonance in azide crystals, theory of the dielectric constant, thermal and photolytic decomposition in the metallic azides, speculations on the initiation of explosion in lead azide.

Paramagnetism in the azide ion is explored, including some theoretical speculation as to the effect of electromagnetic waves on the crystalline structure of the azide ion or radical. (reh)

306 P. E. C. CORPORATION.

FIRST QUARTERLY REPORT, [illegible], n.d. [illegible] Ling. February 9, 1959. Quarterly progress report for 9 October 1958 to February 5, 1959. Army Contract DA-11-009-ENG-4158. Army project [illegible]. Unclassified report.

Reaction rate theory is applied to explosive burning, detonation and initiation of explosives. A heat conduction equation describing the geometry, the medium and boundary conditions is used. A source term (Arrhenius expression) describes the rate of energy release due to reactions. The use of this source term is quite proper when applied to detonation or explosive burning. In the initiation process the source term represents the probability per unit time of a reaction occuring. When large numbers of molecules are present the probability and reaction rate interpretations are equivalent. (vis)

307 Palmieri, Mario and S. D. Ehrlich.

DELAY BLASTING CAP. December 21, 1937. U.S. Patent no. 2,103,014.

This invention describes a device for achieving controlled delay in blasting caps. An electrically-initiated igniting compound ignites a heating compound which heats a metallic member. When the metallic member reaches the necessary temperature, it ignites the main charge of the blasting cap. The metallic member may be either a cup surrounding the heating compound or a rod passing through it. The delay period is varied by substituting inert material for the heating compound and thereby slowing the heating process by reducing the amount of heating compound used. (rh)

308 Hefferkorn, Gerard.

"Zur struktur von Bleiazid." In ZEITSCHRIFT fur NATURFORSCHUNG. 3a: 1948. p. 3-4.

The structure of lead azide is analyzed in terms of the light refraction, crystallization, and the structure of related groups. Evidence in the literature and chemistry is cited.

309 [illegible]

DESCRIPTION OF MANUFACTURE: THE PREPARATION OF PRIMER MIXTURES (PRIMER COMPOSITIONS), revised by [illegible]. Unclassified report.

Presents the standard practice at Picatinny Arsenal for the [illegible] of primer mixtures(compositions). (ama)

310 Picatinny Arsenal.

DEVELOPMENT OF A DETONATING COMPOUND TO REPLACE FULMINATE OF MERCURY, by Sol Livingston. July 30, 1929. P A technical report 64.

Describes the preparation, purification, and properties of mannitol hexanitrate. This material is practically non-hygroscopic, has twice the brisance of mercury fulminate and an explosion temperature of 193°C., and is much less sensitive to impact than mercury fulminate (12 inches vs. 3 inches - one pound weight). When stored at 95°C. in the presence of moisture, the hexanitrate undergoes very rapid decomposition. (mw)

311 Picatinny Arsenal.

TEST OF QUANTITY OF POWDER IN DETONATOR CUP OF M-8 RIFLE GRENADE FUZE, by J. A. Solomon. December 30, 1930. P. A. technical report 3. Unclassified report.

M-8 rifle grenade fuzes loaded with 5 grains (0.5 inch height) of powder gave satisfactory fragmentation using a 1.44 inch length of Ensign Bickford fuse. This length of fuse, however, burned faster than specification allowance. It is recommended, therefore, that the permitted burning time be reduced from 8.3 to 7-8 seconds. (mw)

312 Picatinny Arsenal.

INVESTIGATION OF THE LOWER DETONATOR OF MK. 3 FUZES, BARTLETT-HAYWARD LOTS 3 AND 41, by L. R. Carl. February 16, 1931. P A technical report 23. Unclassified report.

Detail examination of (5) detonators from each of (2) lots of Bartlett Hayward fuzes. Results show that the greatest variation is the mercury fulminate density. The fulminate density in lot 3 was found to be 2.57, while the density in lot 41 was 2.73. (vis)

313 Picatinny Arsenal.

EFFECTIVENESS OF DETONATORS OF VARIOUS HEIGHTS AND DIAMETERS AFTER SURVEILLANCE AT 50°C, by R. L. Carl. March 2, 1931. P. A. technical report 28. Unclassified report.

Periodic tests of detonators of various heights and diameters during storage at 50°C indicated that no gain in storage life results from increasing the diameter beyond .190 inch or increasing the height beyond .215 inch. Assembling the detonator into the explosive train in a reversed position increased the effective life of the detonators from 7 months to 10 months. (reh)

314 Picatiany Arsenal.

STUDY OF THE EXPLOSIVE AND INITIATING CHARACTERISTICS OF DIAZODINITROPHENOL AND OF MIXTURES CONTAINING IT, by O. E. Burton. March 26, 1931. P A technical report 34. Unclassified report.

Discusses the preparation and properties of dinitrodiazophenol. This material is non-hygroscopic, has an explosion temperature of 155°C and an impact of 16 inches when struck by an 8 oz. ball. It is a more effective detonator than mercury fulminate, being able to detonate cast TNT and completely detonate ammonium picrate. It has about twice the brisance of mercury fulminate as measured by the sand test.

In view of its explosive characteristics, further study of dinitrodiazophenol is recommended. (mw)

315 Picatinny Arsenal.

TEST OF .1 SEC DELAY MK. 2B PRIMER DETONATORS MANUFACTURED OF COMMERCIAL BRASS PARTS, by J. M. King. May 12, 1931. P A technical report 52. Unclassified report.

Twenty-five subject delay detonators were tested on a rotary chronograph. Two gave delays above the maximum limit. The variation is due to the size of the delay pellet and not the brass parts used for their assembly.

It was recommended that the bodies, heads and retard carriers of the subject detonator be manufactured from commercial brass, Grade B, half hard, Specification 57-161. (vis)

316 Picatinny Arsenal.

DESIGN OF ELECTRIC PRIMER TESTING SET T1, by C. G. Dunkle. July 9, 1931. P. A. technical report 96. Unclassified report.

A testing set for the field evaluation of electric cannon primers is described. A modified potentiometer which uses the constancy of the amperage rather than the constancy of the voltage as a means of balancing and it measures the resistance of the primer, making it possible to reject primers that have abnormally high or fluctuating resistances or resistances lower than 1/2 ohm. This device is potentially useful for measuring the resistance of detonators, also. (reh)

317 Picatinny Arsenal.

INVESTIGATION OF BRIDGE WIRE FOR SEACOAST CANNON ELECTRIC PRIMERS, by J. A. Solomon. July 14, 1931. P. A. technical report 95. Unclassified report.

On the basis of an investigation of various types of bridge wire, a 54/45 copper/nickel alloy wire with a diameter of .002 inch was chosen. Its breaking strength is 170 grams as compared to 130 grams for the wire now used, and its resistance about 70 ohms per foot as against 32 ohms per foot for the present wire. Details of tests conducted with various types of wire are given in Picatinny Arsenal Chemical Laboratory report 28995, a copy of which is appended to this report. (reh)

318 Picatinny Arsenal.

TESTS OF DETONATORS REMOVED FROM MARK 10 BASE-DETONATING FUZES, by W. T. Ingraham. July 29, 1931. P. A. technical report 105. Unclassified report.

Detonators stored for 3-1/2 years in a magazine and at 30°-35°C to simulate continuous summer temperatures were tested for deterioration. The magazine-stored detonators showed no deterioration, but the 30°-35°C-stored detonators were seriously deteriorated (purity of fulminate reduced from 92.2% to 86.0%, apparent brisance down from 5.5 to 3.8 grams of sand crushed, and complete loss of ability to initiate detonations in the explosive train test). (reh)

319 Picatinny Arsenal.

DEVELOPMENT OF DROP TEST APPARATUS AND DETERMINATION OF SENSITIVITY OF PRIMERS, by P. Varrato. August 19, 1931. P. A. technical report 127. Unclassified report.

A new primer sensitivity drop test apparatus was designed, constructed and installed at Picatinny. Four types of percussion primers - Mk 5, new no. 4, 21-second concussion, and 100-grain percussion primers - were tested with the new apparatus. Results obtained were recommended for inclusion in relevant specifications, and the apparatus itself was recommended for adoption by the Ordnance Corps. (reh)

320 Picatinny Arsenal.

DEVELOPMENT OF AN IMPROVED LOWER DETONATOR FOR THE MK 3 P. D. FUZE, by L. R. Carl. October 13, 1931. P. A. technical report 144. Unclassified report.

A new charge for the detonator under study, consisting of 23.5 grains of tetryl and 28 grains of fulminate, was developed. By shortening the inner cup and using a larger charge, detonator performance was improved. (reh)

321 Picatinny Arsenal.

IMPROVEMENT IN PRIMER MIXTURE FOR T2E1 FUZE, by P. Varrato. October 22, 1931. P. A. technical report 139. Unclassified report.

Insoluble material was removed from shellac used in primer mix thus enabling the mixture to meet both sensitivity and jolt and jumble tests when loaded in the T2E1 fuze. (ama)

322 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE AND INITIATING CHARACTERISTICS OF DIAZODINITROPHENOL AND OF MIXTURES CONTAINING IT, by O. E. Burton. December 1, 1931. P. A. technical report 150. Unclassified report.

Tests were conducted on commercial diazodinitrophenol, mixtures of diazodinitrophenol and potassium chlorate, and diazodinitrophenol stored for 6 months under various conditions. Results of sand bomb tests, explosion temperature determinations, eight-ounce-weight impact tests, and density measurements are given. Storage conditions included ordinary temperature and 50°C, both wet and dry. (reh)

323 Picatinny Arsenal.

DEVELOPMENT OF METHODS OF TESTING ARTILLERY PRIMER CAPS: SECOND PROGRESS REPORT, by J. B. Nichols. January 6, 1932. PA technical report 171. Unclassified report.

The explosive characteristics of primer compositions No. 70, No. 74 and No. 1894 are described. Data is presented for the following: (1) Volume of gas liberated, (2) Impulse of the explosion, (3) Incandescent solids carried by the flame and (4) Sensitivity of compositions to percussion. Results indicate the following: (1) No. 74 liberates more gas than No. 70 which liberates more than No. 1894, (2) No. 70 has a higher impulse than No. 74 which is higher than No. 1894, (3) No. 1894 has the highest percentage of solids, No. 74 slightly less, No. 70 considerably less and (4) No. 70 and 1894 have equal sensitivities but are more sensitive than No. 74. (vis)

324 Picatinny Arsenal.

COMPOUND DETONATORS FOR THE M39 AND T3 TYPE FUZES, by L. R. Cerl. March 18, 1932. P. A. technical report. 199. Unclassified report.

An investigation was conducted of the feasibility of loading T-2 and T-3 type detonators with a compound charge in which the tetryl is added as a preformed pellet. Also studied was the possibility of increasing the thickness of the wall of the detonator so that it would withstand loading pressures without external support. Surveillance tests of the various designs developed were begun at 50°C. The new compound loaded detonator functioned satisfactorily in explosive train tests. (reh)

325 Picatinny Arsenal.

INVESTIGATION OF LOADING OF PERCUSSION PRIMERS, M3, LOT 2759-1, by J. A. Solomon. April 1, 1932. P. A. technical report 196. Unclassified report.

Primers were dimensioned and test fired to determine causes of rupturing of 4 out of 68 previously tested at Aberdeen Proving Ground. 300 were fired in a 37mm Mod. 1916 gun with none rupturing. Reduction of required load from 26 grams to 22.5 ± 1.5 grams was recommended. (reh)

326 Picatinny Arsenal.

STUDY OF THE EFFECT OF THE COMMON IMPURITIES IN MERCURY FULMINATE ON ITS STABILITY: SECOND PROGRESS REPORT, by O. E. Burton. April 14, 1932. PA technical report 203. Unclassified report.

Describes a recrystallization procedure used for the purification of mercury fulminate. The average purity found was 99.77%. The recovery varied from 70 to 86% of the theoretical. The impact sensitivity and quantity necessary for initiation of tetryl was the same as specification grade fulminate prior to purification.

50°C storage tests on recrystallized and specification grade fulminate were undertaken. Results show that pure fulminate deteriorates much more slowly. The purity of recrystallized samples decreased .56%, as compared with an 8.2% decrease for specification samples. (vis)

327 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE AND INITIATING CHARACTERISTICS OF DIAZODINITROPHENOL AND MIXTURES CONTAINING IT, by C. E. Burton. April 28, 1932. P. A. technical report 214. Unclassified report.

Diazodinitrophenol shows no loss in brisance after storage for 12 months under water at ambient temperatures; but that stored at 50°C has shown a considerable decrease, reflected in a greatly lessened initiating value. The latter may be restored by washing the compound with alcohol and ether. Stored for 12 months in copper blasting caps at ambient temperatures and at 50°C, diazodinitrophenol reacted with the copper resulting in a decrease in its sensitivity-initiation by a black powder fuse was found to be inconsistent. Stored for 3 months at 50°C under water, the material showed no appreciable decrease in brisance as measured by the Sand Test. (mw)

328 Picatinny Arsenal.

DEVELOP .2 SECOND DELAY PRIMER DETONATOR FOR EXPULSION CHEMICAL BOMB, by J. M. King. June 11, 1932. P. A. technical report 227. Unclassified report.

A primer detonator which performed satisfactorily in static tests was developed. The desired delay was achieved with a slow burning mixture consisting of potassium nitrate (70-1/2%), sulfur (11%), Charcoal (14%), and resin (4-1/2%). In Aberdeen Proving Ground air drop tests, one out of 3 bombs failed to function, the proving ground alleging that the detonator had caused the failure by functioning instantaneously. Subsequent investigation at Picatinny led to the conclusion that the failures had been caused by too-long firing pins which punctured the primer cap causing loss of obturation needed for proper burning of the black powder delay pellet. (reh)

329 Picatinny Arsenal.

BLACK POWDER IN CONTACT WITH FULMINATE, by C. J. Bain. August 5, 1932. P. A. technical report 250. Unclassified report.

Two groups of detonators were loaded: one with .4 gram tetryl, .25 gram fulminate and .1 gram black powder; the other with the same mixture but minus the black powder. Results of sand bomb tests conducted on detonators from both groups after 5, 8, and 9 months of 50°C storage indicated that the black powder increases rather than decreases the efficiency of the mercury fulminate. The author also cites several components in which fulminate and black powder have been stored together for years with no record of resulting malfunctions. (reh)

330 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE CHARACTERISTICS OF LEAD AZIDE PREPARED COMMERCIALLY: First progress report, by O. E. Burton and J. D. Hopper. August 12, 1932. Technical report 255. Unclassified report.

Three types of lead azide -- ordinary crystalline azide prepared at Picatinny, a Dupont product containing 10% lead carbonate, and colloidal lead azide were evaluated and compared. The report contains an explanation of the relationship of the sensitivity of lead azide to crystal size and discusses the good and bad characteristics of the three types studied. The indirect relationship of hygroscopicity to sensitivity -- through the formation of cupric azide is explained. Photomicrographs of the three types of azide -- at 150X, 1000X, and 2000X -- are included. (reh)

331 Picatinny Arsenal.

MALFUNCTIONING OF MARK 2B PRIMER DETONATORS, by C. J. Bain. August 26, 1932. P. A. technical report 229. Unclassified report.

Picatinny was asked by the Ordnance office to investigate the malfunctioning of Mark 2B primer detonators of lots 4382-1, -2, -3, 4; 5434-1, -2, -3; and 5436-1. Sand tests resulted in a number of low order detonations. It was concluded that the malfunctioning had been caused by the presence of black paint inside the detonator (covering the fulminate charge), by improper loading, or by some design fault. (reh)

332 Picatinny Arsenal.

TESTS OF DETONATORS REMOVED FROM MK. 10. B. D. FUZES - 4TH SERIES OF ANNUAL TESTS, by W. T. Ingraham. September 10, 1932. PA technical report 277. Unclassified report.

Summarizes results of chemical and physical tests on MK X. B. D. fuze detonators and their fulminate charges after storage at ambient temperature and 30-35°C for 4-1/2 years. The detonators stored at ambient temperature did not undergo any appreciable deterioration. The detonators stored at 30-35°C became unserviceable. The purity of the fulminate decreased to 86% in the first three years. After the third year no further decrease occured. (vis)

333 Picatinny Arsenal.

DEVELOPMENT OF COMPOUND DETONATOR FOR THE M39 AND T3 P. D. FUZES, by C. J Bain. November 28, 1932. P. A. technical report 294. Unclassified report.

Explosive train tests were conducted on 7 different types of compound detonators after 6 and 7 months of 50°C storage. Cracking and swelling of almost all the detonator cups was noted after 7 months of storage. Among conclusions reached were that, when perforated closure discs are used, unperforated paper discs should be assembled beneath them to give more confinement. (reh)

334 Picatinny Arsenal.

INVESTIGATION OF EFFECT OF DETERIORATION OF MERCURY FULMINATE ON RATE OF DETONATION, by C. J. Bain. December 2, 1932. P. A. technical report 297. Unclassified report.

Rate-of-detonation data was obtained for mercury fulminate complying with the specification and also for mercury fulminate which had deteriorated to 95.4% purity. Widely varying results were obtained, ranging from 3740 to 5470 meters per second for the specification fulminate, and from 3458 to 4183 meters per second for the 95.4% pure material. However, the authors point to the 300 meters per second difference in average values as possibly significant. (reh)

335 Picatinny Arsenal.

STUDY OF NEW TYPE OF PRIMER COMPOSITION FOR FUZES, by J. B. Nichols. January 17, 1933. P. A. technical report 318. Unclassified report.

To obtain greater uniformity of action in priming composition, a number of mixtures consisting of explosive ingredients only were tested. Previously used priming mixtures had contained both explosive and inert ingredients. It was argued that the non-uniform performance of such mixes arose from non-uniform mixing of these ingredients. Many mixtures tried were too insensitive. Most promising was a 25/25/25/25 mixture of mercury fulminate, tetracene, lead styphnate and PETN. (reh)

336 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE CHARACTERISTICS OF LEAD AZIDE PREPARED COMMERCIALLY: SECOND PROGRESS REPORT, by F. R. Kosting. February 1, 1933. P. A. technical report 326.

X-ray diffraction patterns obtained from crystalline lead azide and commercial non-crystalline lead azide are interpreted. The patterns show that: (a) The apparently non-crystalline lead azide is composed of a mixture of amorphous and crystalline particles having a diameter of $1x10^{-6}$ cm when dry but only $1x10^{-7}$ CM when wet. (b) The definitely crystalline lead azide is composed of unit crystals having a magnitude of $1x10^{-6}$ CM or more.

The non-crystalline lead azide may be referred to as "colloidal" since the amorphous material and crystals possess colloidal dimensions. (vis)

337 Picatinny Arsenal.

DEVELOPMENT OF 2 SECOND DELAY PRIMER DETONATOR FOR EXPLOSION CHEMICAL BOMB, by J. M. King. February 17, 1933. P. A. technical report 330. Unclassified report.

Results (see PATR 227 for previous work) of storage tests by Chemical Warfare Service show no deterioration. As reported, tests in which two detonators were initiated using long firing pins, failed to confirm the hypothesis that puncture of the detonator caps had caused these failures. Similar tests--of detonators with holes drilled in the side of the body--indicated that loss of obturation through puncture can cause failure to fire. One detonator was noticed to function normally with a punctured cap. (reh)

338 Picatinny Arsenal.

TESTS OF DETONATORS REMOVED FROM MK10 B. D. FUZES. FIFTH SERIES OF ANNUAL TESTS, by W. T. Ingraham. May 15, 1933. P. A. technical report 365. Unclassified report.

Chemical and physical tests were conducted with mercury fulminate taken from detonators stored at Picatinny, at Panama, C. Z., and at Fort Winfield Scott in the Ninth Corps Area. Deterioration was evident in the mercury fulminate previously stored at Panama, about equal to the deterioration previously noted in mercury fulminate received after storage in Hawaii. No deterioration was noted in fulminate stored at Picatinny and at Fort Winfield Scott. Thus, a marked difference in storage stability was caused by a temperature difference of only 20° to 25°C -- the difference between average temperatures in the two areas. (reh)

339 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE AND INITIATING CHARACTERISTICS OF DIAZODINITROPHENOL AND MIXTURES CONTAINING IT, by W. H. Rinkenbach and C. J. Bain. August 8, 1933. P. A. technical report 355. Unclassified report.

Samples of commercial diazodinitrophenol, both in bulk and loaded in blasting caps were stored under various conditions of temperature, light and humidity and periodically tested for deterioration. A mixture of diazodinitrophenol with 20% potassium chlorate was loaded into copper blasting caps, stored at 50°C and at ordinary temperatures, and then tested for deterioration. Results of sand tests conducted after one year, 18 months, and 21 months of storage are given in this report. No deterioration of the commercial diazodinitrophenol was evident except when stored under water at 50°C for one year or more. After 18 months of such storage, 0.30 grams of the material would not initiate tetryl. (reh)

340 Picatinny Arsenal.
INVESTIGATION OF THE USE OF LEAD AZIDE AS A SUBSTITUTE FOR MERCURY FULMINATE, by L. R. Carl. August 17, 1933. PA technical report 393. Unclassified report.

Test results indicate that lead azide appears satisfactory, from a functioning standpoint, as a substitute for fulminate in detonators where initiation occurs by flame action. Less azide than fulminate is required to initiate detonation of tetryl so that more tetryl may be used to insure more reliable functioning of an explosive train. Lead azide, however, is too insensitive to stab action to be used without a primer cover charge. (mw)

341 Picatinny Arsenal.
STUDY OF NEW TYPE OF PRIMER COMPOSITION FOR FUZES, by J. B. Nichols. September 13, 1933. Second progress report. P. A. technical report 407. Unclassified report.

A primer composition containing equal parts of mercury fulminate, lead styphnate, tetracene and PETN was found to be less sensitive than 1894, no. 70 or no. 74 to stab action and, therefore, cannot be used in the M39 delay detonator. Attempts to increase the sensitivity by changing the component ratios were unsuccessful. Black powder/lead styphnate or tetracene compositions were also unsuitable for the M39. Two compositions 1) 20/60/20, lead styphnate/tetracene/nitrocellulose and 2) 20/60/2/18, lead styphnate/tetracene/nitrocellulose/smokeless powder offer promise and deserve further investigation. (vis)

342 Picatinny Arsenal.
NATURE OF IMPURITIES IN MERCURY FULMINATE WHICH GAVE UNUSUAL EXPLOSIONS, by S. Livingston and A. J. Phillips. September 25, 1933. P. A. technical report 415. Unclassified report.

Three unusual explosions in the handling of M39 fuze detonators loaded with mercury fulminate from U.S. Army lot 188 led to a thorough investigation of the fulminate to determine whether some impurity was causing the explosions. The only unusual characteristic found was the fulminate from this lot evolved ammonia when treated with a cold 5% solution of potassium cyanide. However, no specific relationship between this reaction and sensitivity was established. (reh)

343 Picatinny Arsenal.
JOLT AND JUMBLE TESTS OF .1 SEC DELAY MK. 2B PRIMER DETONATORS, by L. F. Young. PA technical report 413. Unclassified report.

Firing delays were determined for 0.1 sec Delay Mk 2B Primer Detonators after being subjected to Jolt and Jumble tests. Results indicate that the design of the primer detonator was sufficiently rugged to withstand much more severe handling than would be obtained under the ordinary service conditions. (mw)

344 Picatinny Arsenal.
INVESTIGATE THE FACTORS WHICH AFFECT THE FUNCTIONING OF THE 1894 PRIMER MIXTURE, by F. Varrato. October 20, 1933. P. A. technical report 433. Unclassified report.

Loaded primers were subjected to various standard tests, such as: vibration, jolt and jumble; and storage at 50°C. Proportions of the ingredients and hardness of the abrasive materials used in the mix was varied. Different mixing times, height of charge of mixture, flatness and angle of firing pin, effect of plating the firing pin and hardness of detonator cup were investigated. Results, in terms of effect on sensitivity of the 1894 (M39) mixture, show that the shape of the firing pin has a marked effect. (reh)

345 Picatinny Arsenal.
INVESTIGATION OF THE USE OF LEAD AZIDE AS A SUBSTITUTE FOR MERCURY FULMINATE (DENSITY VS LOADING PRESSURE), by Pete Verrato. January 2, 1934. P. A. technical report 567. Unclassified report.

The density of lead azide at loading pressures up to and including 17,500 pounds per square inch has been determined. Results show that the density of lead azide is approximately 0.80 of mercury fulminate at corresponding loading pressures. (vis)

346 Picatinny Arsenal.

STUDY OF NEW TYPE OF PRIMER COMPOSITION FOR FUSES, by J. B. Nichols. January 5, 1934. P.A. technical report 453. Unclassified report.

A study of lead dinitroresorcinate as an ingredient of priming compositions. Used alone, it functioned satisfactorily in the M39 fuze primer and was fired uniformly by dropping a 1-ounce ball 2.5 inches. Satisfactory performance with higher impulse values and reduced sensitivity resulted from mixing the compound with black powder, ground smokeless powder, or tetracene. Mixtures with tetryl were too insensitive, however. Various combinations of black powder, tetracene and lead styphnate were also tested. (reh)

347 Picatinny Arsenal.

INVESTIGATION OF HALF POM POM PRIMERS, by C. J. Bain. January 10, 1934. P. A. technical report 452. Unclassified report.

Because the half pom pom primers used in the M2 mechanical time fuze had given erratic timing in ballistic tests at Aberdeen Proving Ground, tests were conducted to determine whether the particular primers involved were unusually sensitive. An investigation was also conducted to determine the effect of varying proportion of ingredients, granulation, loading pressure and crimping pressure on the sensitivity of the no. 74 mixture used in these primers. On basis of results, changes in proportions, granulations and pressures were recommended. (reh)

348 Picatinny Arsenal.

INVESTIGATE THE EFFECT OF LOADING PRESSURE ON THE FUNCTIONING OF DETONATORS, by C. J. Bain. April 25, 1934. P. A. technical report 381. Unclassified report.

Describes the effect of loading pressure on 1) sensitivity of detonators to stab action, and 2) efficiency of detonators having a wall thickness of .017 inch. Results show that there is no increase in sensitivity at loading pressures greater than 9000 lbs. per square inch.

Detonators loaded with fulminate are at peak efficiency when pressed at 5000 or 6000 lbs. Compound detonators charged with tetryl gave maximum efficiency at 8000 lbs. loading pressure. A comparison reveals that compound detonators are more efficient than fulminate detonators. (vis)

349 Picatinny Arsenal.

PURIFICATION OF MERCURY FULMINATE - SEMI PLANT SCALE, by L. R. Carl. May 14, 1934. P. A. technical report 510. Unclassified report.

A process for the purification of pound quantities of mercury fulminate is described. The process consists of 1) dissolving one pound of fulminate in 14 lbs. of 28% ammonia and 2) neutralizing with a) 11 pounds of 70% nitric acid at temperatures between 20°C and 35°C, followed by b) 35% nitric acid at temperatures not exceeding 20°C, until neutralization is complete. The recovery is 72-85%. Fulminate recrystallized in this manner has a purity of 99.4%. The impact sensitivity which is 9 inches compares favorably with the value of 8 inches found for commercial material. (vis)

350 Picatinny Arsenal.

STUDY OF THE EFFECT OF THE COMMON IMPURITIES IN MERCURY FULMINATE ON ITS STABILITY, by J. D. Hopper. June 18, 1934. P.A technical report 522. Unclassified report.

Mercury fulminate, purified by one recrystallization from ammonium hydroxide, has a useful life, if stored dry at 50°C, of slightly more than double that of commercial fulminate. The initial rate of decomposition of high purity mercury fulminate is exceedingly low. The decomposition rate becomes increasingly greater as the purity decreases to 97%. Below 97% the rate appears to be uniform.

The brisance of mercury fulminate is effected markedly at purities lower than 93%, the purity of the un-recrystallized fulminate declined below 93% in the tenth month of storage. The recrystallized material remained above this value until the twenty-third month. (vis)

351 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE CHARACTERISTICS OF LEAD AZIDE PREPARED COMMERCIALLY: THIRD PROGRESS REPORT, by J. D. Hopper. June 21, 1934. P. A. technical report 525. Unclassified report.

Comparison of the explosive and physical characteristics of one sample of lead azide obtained from duFont in 1932 and another in 1934. The latter has a slightly lower explosion temperature - 300°C as compared with 325°C, is slightly more sensitive to impact, and is considerably more hygroscopic. The 1932 material, after dry, bulk storage at 50°C for 17 months suffered neither decomposition nor impairment of explosive qualities. (mw).

302 Picatinny Arsenal.

INVESTIGATION OF THE USE OF LEAD AZIDE AS A SUBSTITUTE FOR FULMINATE IN DETONATORS, by C. J. Bain. August 2, 1934. P A technical report 534. Unclassified report.

Describes and reports results of tests on the Mk. XB.D. Fuze with azide and azide mixtures substituted for mercury fulminate. Results indicate that lead azide is a satisfactory replacement for mercury fulminate and offers marked advantage as regards stability. The latter is known to deteriorate in storage. (mw)

303 Picatinny Arsenal.

STUDY OF THE EFFECT OF PRODUCTS OF DECOMPOSITION OF MERCURY FULMINATE, by S. Livingston. August 13, 1934. P. A. technical report 537. Unclassified report.

Mercury fulminate of high purity was exposed at 50°C to contact with each of the known and probable gaseous products of its own decomposition, and also to the vapors of various impurities present in commercial mercury fulminate. Among the impurities tested, acetic acid had the greatest effect, and nitric acid and acetaldehyde also has substantial effect. Carbon dioxide and ethyl alcohol had less effect, respectively than air and water. Mercury fulminate deteriorates more rapidly in closed containers from crushing of the crystals during loading, and because of the presence of certain gases. (reh)

304 Picatinny Arsenal.

INVESTIGATIONS OF LEAD AZIDE AS A SUBSTITUTE FOR FULMINATE IN WET LOADED PRIMER MIXTURES: FIRST PROGRESS REPORT, by C. J. Bain. October 24, 1934. P A technical report 550. Unclassified report.

A wet-loaded primer mixture, designated as 25L, and containing potassium chlorate, antimony sulphide, glass, lead azide and shellac has been developed. This composition, when loaded into M39A2 primer housings, has a sensitivity of 6 inches and successfully passes the jolt and jumble test. Delay elements containing mixture 25L possess normally functioning times. Further evidence of suitability of mixture 25L was gained in the gun tests of eight M39A2 fuzes. These fuzes when assembled to M42 shells and fired yield velocities approaching 2600 ft/sec. (vis)

305 Picatinny Arsenal.

INVESTIGATION OF THE USE OF LEAD AZIDE AS A SUBSTITUTE FOR FULMINATE IN DETONATORS, by C. J. Bain. December 3, 1934. P A technical report 561. Unclassified report.

Work was done along two lines: (a) since previous investigations (PATR 393) had indicated that lead azide is not sensitive to stab action, further study was made of applications where initiation is brought about by flame from a black powder charge, and (b) successful attempts were made to develop a new primer charge for use with lead azide in stab-initiated primers and detonators.

A mixture consisting of 33 parts of 100-200 mesh potassium perchlorate, 33 parts of 100-200 mesh antimony sulfide, 28 parts of lead azide and 5 parts of 150-grain carborundum was found to have the same sensitivity (function at an 8 inch drop of a 4-oz. ball) as mercury fulminate when loaded in M20 detonator cups.

A lead azide detonator having the same outside dimensions as the M-20 was also developed. In this detonator, the usual order of loading was reversed the most sensitive element being loaded first, so that crimping is done against the least sensitive element. (reh)

306 Picatinny Arsenal.

EFFECT OF FOUR POINTED FIRING PINS ON SENSITIVITY OF DETONATORS, by P. Varrato. December 17, 1934. P. A. technical report 566. Unclassified report.

Sensitivity of fulminate and no. 74 primer mixture to initiation by 4-point firing was determined under conditions simulating the M20 and M35 detonators, and compared with results obtained with single-point pins. Results indicated that there is no advantage in the use of 4-point firing pins. (reh)

357 Picatinny Arsenal.

DEVELOPMENT OF METHODS OF TESTING ARTILLERY PRIMERS: THIRD PROGRESS REPORT, by J. B. Nichols. January 8, 1935. F A technical report 580. Unclassified report.

Describes the development of a method for determining the duration of the flame and discusses the results obtained by this method in a study of various priming compositions. These included: F. A. No. 73, No. 1894, No. 74, lead dinitroresorcinate, lead azide, and Winchester Mk V and Standard M39 Primers. A rotating disc chronograph gives a direct means of determining flame duration by measurement of the central angles covered by the trace made by firing the primer against a disc of paper that is rotating at a known constant speed. (mw)

358 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE AND INITIATING CHARACTERISTICS OF DIAZODINITROPHENOL AND MIXTURES CONTAINING IT, by J. D. Hopper. March 28, 1935. F. A. technical report 610. Unclassified report.

The limit of stability of commercial diazodinitrophenol and its mixture with 20% potassium chlorate was determined for both wet and dry storage both at ordinary temperatures and at 50°C. Neither material showed any decrease in brisance after 3 years of dry storage. Similar results were obtained for wet storage at ordinary temperature. Deterioration of brisance occurred throughout wet storage at 50°C, reaching 60% after 19 months, when the material would no longer initiate tetryl. (reh)

359 Picatinny Arsenal.

INVESTIGATION OF THE USE OF GRAPHITE IN TETRYL PELLETS FOR COMPOUND DETONATORS, by C. J. Bain. April 10, 1935. P. A. technical report 609. Unclassified report.

In compound detonators containing tetryl and azide, graphite was used as a lubricating agent in pelleting the tetryl. This report contains the results of an investigation to determine how much graphite could be used without adversely affecting the functioning of the detonator. Lead plate tests showed that as much as 15% graphite could be used without serious adverse effect. 1.5% was established as the minimum graphite needed for satisfactory pelleting. (reh)

360 Picatinny Arsenal.

DEVELOPMENT OF A DETONATING COMPOUND TO REPLACE FULMINATE OF MERCURY, by J. D. Hopper. May 13, 1935. F. A. technical report 624. Unclassified report.

Describes a study to determine whether a commercial sample of nitromannite (containing 2% of ammonium oxalate as stabilizer), obtained from the Atlas Powder Co., could satisfactorily replace mercury fulminate as a detonating material. Results of tests indicate the material to be unsatisfactory. It was found unstable at slightly elevated temperatures, insensitive to initiation from the spit of flame from a black powder fuse, and had a low loading density - 0.87 as compared to 2.98 for mercury fulminate. (mw)

361 Picatinny Arsenal.

STANDARDIZATION OF LEAD PLATE TEST FOR DETONATORS, by C. J. Bain. June 10, 1935. P. A. technical report 628. Unclassified report.

A test fixture is described in which detonators can be tested for both sensitivity and normalcy in terms of their ability to perforate lead discs. This fixture was developed because of the inability of the sand bomb test to accurately evaluate deteriorated detonators, and to distinguish small differences in sensitivity such as those due to overpressing or underpressing during loading. (reh)

362 Picatinny Arsenal.

STANDARDIZATION OF THE SAND TEST FOR DETERMINATION OF THE FUNCTIONING OF DETONATORS AS ASSEMBLED COMPONENTS, by C. J. Bain. June 11, 1935. F. A. technical report 629. Unclassified report.

A sand test bomb suitable for testing detonators as assembled components was developed and successfully used in experimental investigations of the MK 3 fuze, the T19 fuze, and the MK2B primer detonator. (reh)

303 Picatinny Arsenal.

DEVELOPMENT OF LEAD AZIDE LOADED MK. 2B PRIMER DETONATORS, by M. L. Mathsen. October 30, 1935. P. A. technical report 657. Unclassified report.

To further evaluate lead azide as a possible substitute for mercury fulminate (see also technical reports 393 and 534) 20 lead azide loaded Mk 2B primer detonators were tested in the sand bomb. Average amount of sand crushed was 94 grams, indicating satisfactory performance. Aluminum, rather than gilding metal bodies were used, to avoid possible formation of the extremely sensitive cupric azide. (reh)

304 Picatinny Arsenal.

SENSITIVITY OF MERCURY FULMINATE AS INFLUENCED BY DETERIORATION, by P. Varrato. January 9, 1936. P. A. technical report 680. Unclassified report.

Effect of 50°C storage on the mercury fulminate charge in the M39 fuze was studied, in connection with the reconditioning of two lots of fuses and the proposed substitution of perforated discs for solid discs in their detonators. After 2 months of storage, sensitivity was 3 inches as opposed to 8 inches before storage. No further change in sensitivity occurred till 7 months when failures were noted. Sensitivity was determined with a free-falling, 4-ounce weight dropped on a firing pin having a .015-.005 inch flat and a 26° included angle. (reh)

305 Picatinny Arsenal.

INVESTIGATION OF THE LOADING OF LEAD AZIDE DETONATOR AND SUPERQUICK PRIMER AND THE DELAY FOR THE M45 FUZE, by C. J. Bain. April 8, 1936. P. A. technical report 719. Unclassified report.

Numerous low order detonations which occurred in ballistic tests of the M45 fuse at Aberdeen Proving Ground led to an investigation of the explosive train and to establishment of a new method of loading and assembling the detonator, primer, and relay. A thicker detonator wall was adopted, to eliminate shearing of the wall during crimping. Higher loading pressures were made possible by using the reverse order of loading (most sensitive ingredient first). (reh)

306 Picatinny Arsenal.

DEVELOPMENT OF LEAD AZIDE LOADED MK. 2B PRIMER DETONATORS, by M. L. Mathsen. PA technical report 748. Unclassified report.

Results of Sand Bomb, Delay, and Jolt and Jumble tests of lead azide loaded Mk. 2B primer detonators. The detonators were loaded with 175 mgs. of lead azide, 1155 mgs. of tetryl plus two percent of graphite. Recommends that an experimental lot be manufactured for Proving Ground tests. (mwl)

307 Picatinny Arsenal.

TEST OF LEAD AZIDE AS A SUBSTITUTE FOR MERCURY FULMINATE IN THE M100, M101 and M102 TAIL BOMB FUZES, by F. V. Ludden. August 4, 1936. P. A. technical report 749. Unclassified report.

Tests simulating explosive train conditions indicated that, as assembled in the M100, M101, and M102 tail bomb fuzes, the lead azide relay and the lead azide-tetryl detonator would cause satisfactory functioning of the boosters used with these fuses in demolition bombs. (reh)

308 Picatinny Arsenal.

TESTS OF LEAD AZIDE-TETRYL DETONATORS IN M20 BOOSTERS, by J. A. Batley. September 28, 1936. PA technical report 561. Unclassified report.

A lead azide-tetryl detonator has been found suitable for use in the M20 Booster in combination with Time Fuses, M39A2 and T16 P.D. Fuzes. The detonator can be handled safely and functions satisfactorily. Detail design drawings are included. (via)

369 Picatinny Arsenal.

STUDY OF THE SENSITIVITY TO IMPACT OF METALLIC SALTS OF PICRIC ACID, by J. D. Hopper. September 3, 1936. P. A. technical report 764. Unclassified report.

Heavy metal picrates of iron, copper, zinc, aluminum, cadmium, nickel, and chromium were tested for sensitivity in highly hydrated form and found to be extremely insensitive to impact. Anhydrous forms of copper, zinc, and cadmium picrates, formed by heating the hydrated forms at 150°C had the same sensitivity as 50/50 amatol. Ferric, chromic, and nickel picrates, dehydrated at 100°C, had the sensitivity of recrystallized tetryl; and aluminum and ferrous picrates were equivalent to Explosive D and picric acid. When dehydrated at 120°-140°C, nickel and ferric picrates become very sensitive to impact. (reh)

370 Picatinny Arsenal.

INVESTIGATION OF THE USE OF LEAD AZIDE AS A SUBSTITUTE IN DETONATORS: FIFTH PARTIAL REPORT, by Fete Varrato. November 17, 1936. P.A. technical report 784. Unclassified report.

Stability tests on lead azide, tetryl charges and charges containing lead azide primer mixture were conducted. Results show that the stability of the azide-tetryl detonator used in the mk 2B primer is normal after 39 months storage. At 50°C, M45 fuse detonators containing azide priming mixture, are stable for 2 years at 50°C and 56 days at 80°C. M45 fuse delay primers loaded with wet azide primer mixture withstand 50°C for 2 years and 80°C for 70 days. Similar detonators charged with mercury fulminate failed to function after storage for 7 months at 50°C and 7 days at 80°C.

It is concluded that lead azide is superior to fulminate in stability. (vis)

371 Picatinny Arsenal.

INVESTIGATE THE USE OF LEAD AZIDE AS A SUBSTITUTE FOR MERCURY FULMINATE, by F. Varrato. December 8, 193[illegible]. P. A. technical report 788. Unclassified report.

A method was developed for determining what length of air gap may be allowed between the detonator and the booster lead. Application of this method indicated that the M20 detonator would initiate detonation in the lead through a distance of .1875 inch, which is three times the distance that exists in the normal fuze-booster assembly of the M20. (reh)

372 Picatinny Arsenal.

TEST OF PRIMACORD, by C. J. Bain. May 17, 1937. P. A. technical report 829. Unclassified report.

The sensitivity of primacord to shock, flame, and friction was determined and compared with that of Cordeau fuse. On the basis of results of impact tests, steel shoe friction pendulum tests, and tests to determine sensitivity to flame from smokeless powder, it was concluded that primacord is only slightly more sensitive to impact than Cordeau fuse and sufficiently insensitive to flame and friction for demolition work. (reh)

373 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE AND INITIATING CHARACTERISTICS OF DIAZODINITROPHENOL AND MIXTURES CONTAINING IT, by C. J. Bain. May 18, 1937. P. A. technical report 827. Unclassified report.

As diazodinitrophenol was being used in commercial blasting caps it was considered advisable to investigate this material as a detonator explosive for use in ammunition. Preliminary investigation had shown that it would detonate tetryl when loaded at approximately 3000 lbs. per sq. in. but no data were available regarding its functioning in detonators of the M45 type. It was found that in this detonator, either the amount of material used or the sensitivity of the explosive was not sufficient to permit initiation of a high order detonation in the tetryl lead of the booster. It was, therefore, concluded that diazodinitrophenol was not adaptable for use in fuzes.

374 Picatinny Arsenal.

INVESTIGATE THE SUITABILITY OF LOADING DETONATORS BY COMMERCIAL METHODS, by C. J. Bain. June 3, 1937. P. A. technical report 832. Unclassified report.

An investigation was conducted to determine whether detonators of the M45 type could be loaded by commercial methods. A small-scale charging and loading tool which showed promise was developed. Detonators tested with minimum and maximum charges performed satisfactorily. Results of the investigation indicated that M45 type detonators can be satisfactorily loaded by a modified commercial method, which is described in the report. (reh)

375 Picatinny Arsenal.
INVESTIGATION COVERING DETERMINATION OF THE RATE OF DETONATION OF VARIOUS TYPES OE DETONATORS: FINAL REPORT, by Fete Varrato. June 10, 1937. PA technical report 833. Unclassified report.

A method for determining the rate of detonation of initiating explosives has been developed. Tests using this method show that lead azide-tetryl or mercury fulminate-tetryl detonators have detonation rates 1/5 higher than detonators containing pure azide or fulminate. It was also found that the rate increased when an air gap of .367 inches was used. However, the rate is reduced to 1/2 of that obtained in a solid column if an air gap of 36 inches is employed. (vis)

376 Picatinny Arsenal.
STUDY OF THE EXPLOSIVE CHARACTERISTICS OF LEAD AZIDE PREPARED COMMERCIALLY, by J. D. Hopper. August 12, 1937. PA technical report 852. Unclassified report.

Storage of commercial lead azide for 25 months under 50% alcohol solution and at magazine temperatures has no effect on the brisance, purity and sensitivity of the material. This manner of storage is recommended whenever freezing may occur. Storage of loose, dry material at 50°C causes an increase in impact sensitivity, from 6 inches to 3 inches in the P. A. Drop Test. (mw)

377 Picatinny Arsenal.
INVESTIGATION OF THE PRACTICABILITY OF UTILIZING A NEW TYPE OF PRIMER COMPOSITION FOR FUZES, by C. J. Bain. October 27, 1937. PA technical report 859. Unclassified report.

A study of possible priming compositions indicates that lead dinitroresorcinate and tetracene are not sufficiently sensitive for use alone as charges in standard primers. The addition of ground glass and carborundum increases the sensitivity but not to the point where it compared favorably with the sensitivity of the 1894 primer mixture. Tetracene, with 5% of carborundum, was found sensitive enough for use as a cover charge for lead azide. (mw)

378 Picatinny Arsenal.
STUDY OF LEAD AZIDE PRIMER MIXTURES FOR NEW NO. 4 AND NO. 7 PRIMERS, by C. J. Bain. January 7, 1938. PA technical report 866. Unclassified report.

No. 7 Primers loaded with an azide primer mixture gave satisfactory functioning in T-16 delay elements and Mk. 2C primer detonators. The primer mixture contained potassium chlorate - 30%, antimony sulfide - 30%, glass - 30%, lead azide - 8%, and shellac - 2%.

No. 4 Primers with azide mixture did not give satisfactory drop test results, but no failures were obtained when they were assembled in fragmentation grenade bouchons. (mw)

379 Picatinny Arsenal.
SENSITIVITY OF TIIE1 DETONATORS, by C. S. Davis. February 17, 1938. PA technical report 882. Unclassified report.

The results of low altitude bomb drop tests using the TIIE1 detonator with various primer compositions are summarized. It is concluded that the sensitivity of the TIIE1 detonator may be increased by the use of appropriate amounts of No. 74 primer mixture and mercury fulminate with tetryl. (mw)

380 Picatinny Arsenal.
SENSITIVITY TEST OF M29 PRIMERS, by D. R. Beeman. July 8, 1938. PA technical report 893. Unclassified report.

Describes specifications prepared for the M29 Primer used in the M43 and T15 mechanical time fuzes. Sensitivity tests indicate that the primer should function consistently under the impact of a 3-ounce ball dropped 11 inches using a firing pin having a flat point, 0.02 - 0.01 inch diameter, and a 50° included angle. This requirement is incorporated in Specification FXS-592 covering the M29 Primer. (mw).

301 Picatinny Arsenal.

INVESTIGATION OF THE SENSITIVITY OF LEAD AZIDE PRIMERS, by C. S. Davis. October 31, 1938. Technical report 932. Unclassified report.

Work has been directed toward increasing the sensitivity of lead azide primers. Drop tests with FA70 primer mixture, in which TNT has been replaced with lead azide, show that the modified composition is more sensitive than standard fulminate mixture. This modified FA70 mixture is also more sensitive than the standard azide mixture ordinarily used. In view of the promising results obtained it is recommended that ballistic tests be conducted on fuzes provided with the modified FA70 mixture. (vis)

302 Picatinny Arsenal.

INVESTIGATION OF EQUIPMENT FOR TESTING SENSITIVITY OF PRIMERS, by G. E. Rogers. November 7, 1938. PA technical report 934. Unclassified report.

Impact values obtained using Picatinny primer sensitivity equipment cannot be compared to those obtained by commercial suppliers of primers or by Frankford Arsenal. New No. 1 primers failed when tested for acceptance under impact of a 15/16 inch diameter steel ball (1.94 oz.) falling 12 inches, although they had previously passed this test at the manufacturers plant.

Investigation revealed the following causes: (1) Impact of ball on firing pin head was off center, (2) The intensity with which the ball hit the pin varied, and (3) The weight of the Picatinny firing pin was twice as heavy as the Frankford Arsenal pin. Modification of the existing equipment is recommended. (vis)

303 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE CHARACTERISTICS OF LEAD AZIDE PREPARED COMMERCIALLY, by J. D. Hopper. December 6, 1938. Technical report 944. Unclassified report.

The impact sensitivity of dry commercial lead azide loaded in detonators under 10,300 pounds per square inch pressure was determined before and after storage at 50°C for 12 months. Results indicate a tendency toward increased sensitivity. This finding is in agreement with the results of storage tests previously obtained using unpressed commercial lead azide.

It is concluded that the increase in sensitivity is due to the drying out and hardening of the organic binding agent present in the material. (vis)

304 Picatinny Arsenal.

TEST OF MODIFIED M12 DETONATORS SUBMITTED BY THE E. I. DUPONT DE NEMOURS AND COMPANY, by F. Schultze. March 2, 1939. PA technical report 955. Unclassified report.

Tests were made to determine whether proposed changes in the manufacture of the M12 detonator could be adopted without impairing the efficiency of the detonator. Based on satisfactory results, the duPont loading is recommended for production. (mw)

305 Picatinny Arsenal.

LEAD DINITROSORESORCINATE USED AS AN INGREDIENT IN PRIMER COMPOSITION, by A. J. Phillips. March 29, 1941. Technical report 1079. Unclassified report.

Tests have been made on lead dinitrosoresorcinate, furnished by the Western Cartridge Co., in order to determine its suitability for use in priming compositions used in pyrotechnic assemblies. Results have shown that the resorcinate is more stable and less sensitive toward impact than mercury fulminate.

Lead dinitrosoresorcinate should be classed with tetracene rather than lead azide or mercury fulminate since it is easy to ignite and gives a large volume of flaming gas. It is difficult to detonate and has a low brisance.

It is recommended that priming compositions containing this substance be authorized for use in pyrotechnic assemblies. (vis)

306 Picatinny Arsenal.

TEST OF LEAD AZIDE BARRICADE, by I. O. Drewry. August 25, 1941. Unclassified report.

An aluminum, steel plate and plywood barricade was designed and tested by high order detonation of six ounces of lead azide. Considerable damage occurred and recommendations are made to limit or prevent such damage in future tests. Photographs and specification drawings of the barricade are included.

387 Picatinny Arsenal.

RADIO EQUIPMENT DESTROYER, by J. R. Hopkins. November 27, 1941. PA technical report 1132. Unclassified report.

Discusses and describes with drawings an electric detonator, loaded with 26 grains of lead azide, to be used for the destruction of secret radio equipment used in U. S. Army and Navy airplanes. Ten such detonators are strategically wired into a receiver-transmitter for the desired destruction.

Photographs of receiver-transmitters and incorporated detonators are included. (mw)

388 Picatinny Arsenal.

STUDY OF THE ACTION OF LEAD AZIDE ON COPPER, by K. S. Warren. February 21, 1942. Technical report 1152. Unclassified report.

Storage tests at 50°C on commercial lead azide and pure lead azide in contact with copper strips were performed under the following conditions: 1) dry, 2) dry, in an atmosphere of CO_2, 3) at 90%:R.H. and 4) at 90% R.H. containing CO_2. Results show that no copper azide is formed when storage is carried out in the absence of moisture or in dry CO_2. In the presence of moisture, both pure and commercial azide react with copper to produce copper azide.

Since reaction occurs in the presence of moisture, a condition which is difficult to prevent, it is recommended that the use of copper alloys be prohibited in ammunition where metal is in contact with lead azide. (vis).

390 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE CHARACTERISTICS OF LEAD NITROAMINOGUANIDINE, by A. J. Phillips. July 27, 1942. Technical report 1183. Unclassified report.

Methods for the preparation of the barium, copper and lead salts of nitroaminoguanidine and the lead salt of nitroguanidine are described. The explosive characteristics of the lead salts are tabulated. The lead salt of nitroguanidine is inferior to the salt of nitroaminoguanidine with respect to brisance.

Lead nitroaminoguanidine has been found to have a high degree of sensitivity, a relatively low brisance and stability higher than that of mercury fulminate. The compound offers promise for use as a constituent in primer compositions. (vis).

391 Picatinny Arsenal.

M48 P. D. FUZE PRIMER MIXTURE (GUM BINDER), by M. C. Epton. July 28, 1942. P. A. technical report 278. Unclassified report.

Describes the development of a water-soluble gum-arabic binder to replace an alcohol-soluble shellac binder in the M48 delay primer mixture. This mixture consists of ground glass - 30. 6%, mercury fulminate - 33. 6%, potassium chlorate - 14. 3% and antimony sulfide - 21. 5%. The gum arabic bound mixture has a surface which is rougher than the shellac bound mixture and will therefore have less tendency to produce sensitivity failures. Results of sensitivity, delay, jolt and jumble tests indicate that gum arabic is a satisfactory binder in the M48 delay primer. (mw)

392 Picatinny Arsenal.

DESCRIPTION OF MANUFACTURE: THE PREPARATION OF PRIMER MIXTURES (PRIMER COMPOSITIONS), by E. Rudensey. Revised to September 1942. Unclassified report.

Describes the sequence of operations for the manufacture of a primer composition consisting of antimony sulfide, potassium chlorate, lead azide and inert materials. Photographs of apparatus and the use thereof in many operations are included. (mw).

393 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE CHARACTERISTICS OF ACETONE PEROXIDE, by A. J. Phillips. October 5, 1942. Technical report 1202. Unclassified report.

Outlines methods of preparation and explosive characteristics of acetone diperoxide and acetone triperoxide. Tests on the triperoxide show that the compound is unaffected by water, has an impact sensitivity of 10 cm. with a 500 gram weight as compared to lead azide with an impact of 10 cm. with a 2000 gram weight, and has a brisance which is only slightly lower than TNT but higher than mercury fulminate.

These compounds are not militarily significant since they are volatile at room temperature. (vis)

304 Picatinny Arsenal.

STUDY OF THE EXPLOSIVE CHARACTERISTICS OF PHENYLDIAZOSULPHIDE, by W. R. Tomlinson, Jr. October 29, 1942. PA technical report 1208. Unclassified report.

Describes the preparation and several explosive properties of phenyldiazosulfide and p-nitrophenyldiazosulfide. The former was found to be so unstable that it could not be kept at room temperature for more than several minutes without decomposition. Upon drying it exploded spontaneously. The more stable p-nitrophenyldiazosulfide is so sensitive (impact of 5 cm. using Bureau of Mines Drop Test apparatus) that it offers no promise as a military explosive. (mw)

305 Picatinny Arsenal.

EXAMINATION OF UNFIRED 20MM H. E. ROUND OF JAPANESE AMMUNITION, by A. B. Shilling. 28 January 1943. PA technical report 1236. Unclassified report.

The complete 20 mm round under investigation consists of a fuzed, thin-walled H. E. shell crimped in a brass cartridge case. The shell is loaded with a cyclonite bursting charge and fuzed with a point detonating fuze of a non-delay type. The cartridge case is of conventional design, and is primed with a short percussion type primer.

The projectile primer composition was found to be mercury fulminate - 28.8%, antimony sulfide - 31.5%, and potassium chlorate - 39.7%.

Photograph and drawings of the round are included.

306 Picatinny Arsenal.

STUDY PROPERTIES OF TETRAMINO CUPRIC NITRATE, by A. J. Phillips. June 28, 1943. Technical report 1302. Unclassified report.

Compatibility of copper foil in contact with ammonium nitrate, 80-20 and 50-50 amatols (containing various percentages of moisture) was determined for storage at 50°C in both open and closed containers. Results show that in closed containers, tetramino cupric nitrate is formed very readily in the presence of ammonium nitrate, less so with 80-20 amatol, and to little extent with 50-50 amatol. In open containers, this salt is not formed. In tests where significant moisture is present, the copper strips corrode to form basic nitrates which react with additional copper to yield the tetramino compound.

It is concluded that no copper or copper alloys should be used in any part of the equipment which may come into contact with amatol during its manufacture. (vis)

307 Picatinny Arsenal.

EXAMINATION OF UNFIRED 5 CM (50mm) A. P. C., H. E. COMPLETE ROUND OF GERMAN AMMUNITION (SHORT CASE) FMAM-68, by A. B. Schilling. July 22, 1943. Technical report 1238. Unclassified report.

Five 50mm high explosive rounds of German ammunition were examined. Analysis of the contents revealed the presence of a 90% PETN-10% carnauba wax explosive charge. The fuze assembly contained primer and detonator charges. The primer charge was composed of 56% potassium chlorate, 36% antimony sulfide and 7% abrasive. Upper charge was 57% lead azide and 43% lead styphnate, while the lower charge contained PETN.

The steel cartridge case contained a double base, single perforated propelling charge, with a nitrocellulose powder igniter and a short type percussion primer containing mercury fulminate, potassium chlorate and antimony sulphide. (vis)

308 Picatinny Arsenal.

LOADING OF THE M16 DELAY ASSEMBLY, by S. Slemrod. 28 July 1943. Unclassified report.

To load M16 delays successfully it is necessary that delay composition pellets be kept at a constant density. Failure to maintain constant density will result in erratic burning times. Characteristics of the M16 delay composition were determined so that satisfactory burning times will be obtained. As long as the pelleting pressure does not exceed the reconsolidation pressure: 1) a higher delay pellet density results in a slower burning rate and 2) a straight line variation exists between the burning time of constant density pellets and the weight of delay composition. Other relationships, having been determined, are discussed and plotted graphically. (mw)

309 Picatinny Arsenal.

EXPLOSIVE PROPERTIES OF COMPLEX COMPOUNDS, by W. R. Tomlinson, Jr. November 5, 1943. PA technical report 1304. Unclassified report.

Hexammino cobaltic nitrate was found to be an explosive, and therefore other similar complexes were studied. Several cobaltic and chromic ammines containing nitrite, nitrate, and perchlorate radicals were found to be sensitive brisant explosives with drop test values (2 kg. weight) varying from 25 to 50 cm and a brisance approaching that of TNT. These compounds also varied widely in sensitivity to initiation, some being as insensitive as amatol and others as sensitive as Haletite or RDX. One compound hexammino chromic perchlorate was sensitive to the spit of a black powder fuze. All were of satisfactory thermal stability, and most possessed water solubilities of 1-2%. Those without oxygen were found to be inert. The authors suggest that some of these compounds may find applications as initiators or primers. (reh)

400 Picatinny Arsenal.

DATA ON LOADING OF STANDARD DETONATORS, by L. S. Wise. 7 December 1943. PA technical report 1330. Unclassified report.

Data relative to the heights of explosive charges of the various standard fuze detonators, and other related information was obtained. This data is summarized in the enclosed tables.

401 Picatinny Arsenal.

ACTION OF EXPLOSIVES ON METALS USED IN AMMUNITION, by L. H. Eriksen. 10 February 1944. PA technical report 1388. Unclassified report.

Dry lead azide, stored for 3 months, both at ambient temperature and at 50°C in contact with strips of magnesium, magnesium-aluminum alloy - J-1, copper, brass, etc. had little, if any, corrosive action. Moist (0.5%) lead azide at 50°C, had a slight tarnishing effect only on magnesium. (mw)

402 Picatinny Arsenal.

PROPERTIES OF POSSIBLE CONSTITUENTS OF PRIMER COMPOSITIONS, by K. S. Warren. 10 February 1944. PA technical report 1389. First progress report on metallic salts of chlorous and oxalic acids. Unclassified report.

Describes the preparation and sensitivity characteristics of the lead, silver and mercuric salts of chlorous and oxalic acids. Lead chlorite has a BM impact sensitivity of 30 cm. whereas the silver and mercuric salts have values of 8 cm. and 4 cm. The oxalates possess impact sensitivities comparable to TNT. The chlorites were found to be less stable than lead azide toward heat.

The salts of these acids are not recommended as primer constituents because 1) chlorites are unstable toward heat, 2) oxalates are too insensitive to impact. (vis)

403 Picatinny Arsenal.

DEVELOPMENT FOR A STABLE PRIMER MIXTURE FOR M26 PRIMER: First Progress Report, by K. S. Warren. 21 February 1944. Unclassified report.

An improved primer composition, more stable than mercury fulminate, has been developed for use in the M26 primer. PA 100 contains lead azide, is stab sensitive and is equivalent to fulminate although its shattering force and blast effect is less. Bot. compositions have similar flame ranges which are suitable for the ignition of Army black powder. (vis)

404 Picatinny Arsenal.

GASLESS POWDERS FOR DELAY ELEMENTS OF FUZES: THIRD PROGRESS REPORT, by David Hart. 22 March 1944. PA technical report 1406. Unclassified report.

A new non-gaseous fuze powder containing barium chromate, manganese and sulfur has been developed for use in M16A1 delay elements. The powder is readily ignitable when compressed to high density and gives better impact results than standard lead chromate-silicon delay powder. Preliminary storage tests at 65°C indicates a slight lengthening of the burning time. (vis)

405 Picatinny Arsenal.

INVESTIGATION OF PRIMER MIXTURE FOR FUZE, CHEMICAL, MINE, A-1, N.M, M5, by K. S. Warren and M. C. Epton. 13 April 1944. Unclassified report.

Considerable preliminary grinding of potassium chlorate and lead thiocyanate, ingredients in the primer mixture for the M-5 Chemical Mine Fuze, resulted in the formation of agglomerates during the blending process, thereby preventing adequate blending. Systematic investigation of this trouble showed that progressive reduction of the amount of preliminary grinding similarly decreased the tendency of the ingredients to cake or agglomerate during blending. It was concluded that the standard igniting mixture for the M31 detonator, composed of potassium chlorate and lead thiocyanate of standard granulations in approximately the same proportions as the original M-5 mine fuze is a satisfactory replacement for the latter in the subject fuze. (mw)

406 Picatinny Arsenal.

PROPERTIES OF POSSIBLE CONSTITUENTS OF PRIMER COMPOSITIONS, by K. S. Warren. 31 August 1944. PA technical report 1442. Unclassified report.

An investigation was conducted to determine if polythiocyanogen ($(SCN)_x$), as a substitute for lead thiocyanate ($Pb(SCN)_2$), might be a more effective sensitizer and fuel in primer mixtures. Sensitivity to stab action of M26 primers loaded with various primer mixtures containing polythiocyanogen, showed that this compound is an efficient sensitizing agent. Although the thiocyanogen was found equivalent or superior to lead thiocyanate, as a sensitizing agent, it showed a slight tendency to tarnish copper under humid conditions and was difficult to prepare so as to have uniform composition and properties. (mw)

407 Picatinny Arsenal.

COMPILATION OF DATA ON THE COMPOSITION OF FOREIGN PRIMERS AND DETONATORS, by K. S. Warren. 28 September 1944. PA technical report 1450. Unclassified report.

A tabulation of compositions used in foreign primers and detonators. Calcium silicide was found in a number of German percussion elements. Fuze primer compositions were of the usual type, containing potassium chlorate, antimony sulphide, mercury fulminate and an abrasive.

French detonators contained black powder as the upper charge and mercury fulminate as the base charge, while Japanese detonators contained tetryl as the base and lead azide or mercury fulminate as the upper charge. A lead azide cover charge for a PETN detonator was rather common among German assemblies. The Italian detonator contained a mixture of potassium chlorate, antimony sulfide and mercury fulminate. (vis)

408 Picatinny Arsenal.

EFFECT OF VARIATIONS IN SHAPE OF FIRING PIN POINTS ON SENSITIVITY OF DETONATORS, by S. J. Odierno and M. C. Gray. November 17, 1944. P. A. technical report 1475. Unclassified report.

Tests were conducted to determine the effect of variations in contour of firing pin points on the functioning of detonators, to serve as a basis for establishing suitable limits for service pins. Results of tests with 32 groups of firing pins with various points indicated that a sharp corner at the point where the flat end joins the tapered section was more conductive to sensitivity of standard detonators of the type tested, than was a point with a radius; also, that firing pins with .007 inch diameter flats were more conducive to sensitivity than those having .015 inch flats. In addition, it was indicated that as the included angle of the point was reduced, improved sensitivity was obtained down to an angle of 16°, the lowest angle tested. It may be noted that no important differences were indicated between results obtained with free machining cold draw WDX-1314 steel firing pins and those with aluminum alloy, Condition T pins, the two materials used for this investigation.

409 Picatinny Arsenal.

THE SENSITIVITY OF DEXTRINATED LEAD AZIDE TO FLAME, by J. Rubin. 12 January 1945. PA technical report 1485. Unclassified report.

Effect of loading pressures (5,000 to 20,000 psi.), encountered in loading operations upon the flame sensitivity of dextrinated lead azide. There was no significant change in the brisance of dextrinated lead azide, as determined by sand test, when the loading pressure was increased from 5,000 to 20,000 psi. Also, the sand test value of thin layers of dextrinated lead azide was a linear function of the column length down to layers as thin as 0.11 cm. (0.028 inch). Dextrinated lead azide, unlike mercury fulminate, is not characterized by a "critical column height" below which it burns instead of detonating. If lead azide is so characterized, its "critical height" is so low as to be of no practical significance. (mw).

410 Picatinny Arsenal.

THE SENSITIVITY OF DEXTRINATED LEAD AZIDE TO FLAME, by J. Rubin. May 14, 1945. Technical report 1528. Unclassified report.

A study was made of the effects on detonator sensitivity of changes in the material and thickness of the disc superimposed on the lead azide charge of the modified M31 detonator.

It was found that (a) an aluminum detonator disc provides a higher degree of sensitivity to initiation by flame than a gilding metal disc of the same thickness, and (b) a nitrocellulose disc of considerably greater thickness is as satisfactory in this respect as the aluminum disc.

The materials and thicknesses tested were: gilding metal (Spec. 57-171-2), 0.0011 - 0.0016 inch; aluminum (Type II, Class A, QQ-A-561, 0.0011 -0.0012 inch; 92/8 NC/camphor, 0.0030 ± 0.0001 inch and 80/20 NC/camphor, 0.0105 ± 0.001 inch. (teh)

411 Picatinny Arsenal.

SURVEILLANCE TESTS ON M61A1 PRIMER DETONATORS CONTAINING TYPE I CLASS B DELAY POWDER, by J. E. Osmun. July 16, 1945. P. A. technical report 1546. Unclassified report.

Forty-day surveillance tests at 65°C were conducted with Type I, Class B delay powder containing barium chromate supplied by three manufacturers. In one case, the barium chromate contained a relatively high percentage of water soluble material and the finished powder had therefore increased hygroscopicity. This powder proved unsatisfactory. The other two powders, made from barium chromate which contained only .05% or less of water soluble material, produced very few failures (4 out of 838, and none out of 289). (reh)

412 Picatinny Arsenal.

DEVELOPMENT OF PRIMER COMPOSITION FOR THE M41 PRIMER, by K. S. Warren. October 15, 1945. P. A. technical report 1569. Unclassified report.

Because the FA 100 primer composition used in the M41 primer would not reliably initiate the M31 detonator in the T46, T48 and T49 bomb fuzes, a new and improved primer mixture was sought. A 50/35/15 mixture of potassium chlorate (grade A, class 2)/lead sulfocyanate/aluminum (grade B) proved satisfactory and was recommended as a replacement of the FA 100 composition in this application. The other compounds in this mixture did not corrode the aluminum at temperatures as high as 50°C. (reh)

413 Picatinny Arsenal.

INVESTIGATION OF INITIATION SYSTEMS FOR FRAGMENTATION, by H. Liber, May 17, 1946. P. A. technical report 1599. Unclassified report.

The Corps of Engineers Blasting Cap (Type II) was indicated to be a more effective initiator than the M17 detonator based on fragmentation and sand test results obtained with a simulated explosive train test fixture in which the spacing between the initiator could be varied.

In conjunction with the above, a limited number of tests indicated that the use of an open lead cup in the test fixture gave fragmentation and sand test results which were superior to those obtained when a closed lead cup was used; however, this difference in results was significant only when confinement of the initiator and spacing between the initiator and lead cup were extended to adverse extremes.

414 Picatinny Arsenal.

INVESTIGATION OF TWO DELAY DETONATORS (ONE FLAME INITIATED, .10 SECOND, AND ONE STAB INITIATED, .02 SECOND) DEVELOPED BY COMPANY A, by J. P. Wardlaw. July 8, 1947. P. A. technical report 1657. ORD projects TM1-5016A and TM1-5016B. Unclassified report.

Two types of delay detonators -- one a .10-second delay design functioned by flame and the other a .20-second delay design functioned by a firing pin -- were subjected to rough handling or high and low temperature storage tests to simulate service conditions. They were then tested for delay time and sensitivity in comparison with control groups. The delay times of both types of detonator were adversely affected by the rough handling and extreme temperature storage tests. (reh)

415 Picatinny Arsenal.

BLACK POWDER FOR ARTILLERY PRIMERS (DETERMINE METHOD TO OVERCOME AUTOMATIC LOADING DIFFICULTIES), BY P. B. Tweed. December 30, 1948. Technical report 1711. Project ERO AX-5. Unclassified report.

Difficulties encountered in the volumetric loading of black powder into artillery primers included: overfilling of primer cups causing powder to be crushed in assembly; and failure of machine to hold the weight of the charge within prescribed limits. These difficulties were attributed to variations in particle shape and in the surface condition of the grains, factors not covered by relevant specifications. To eliminate these difficulties, the practicability of using apparent density or specific surface tests was investigated. The Arkansas Ordnance plant method was found to give more reproducible results than other methods studied, and no difficulty was experienced in obtaining the prescribed charge weight (100 ± 0 grain) for the M1B1A2 primer. Out of 7 samples having apparent densities of 1.11 grams per ml or less, 3 were so bulky that they filled the body excessively. Out of 22 samples having apparent densities of 1.12 or more, none were duds. (reh)

416 Picatinny Arsenal.

STANDARD TESTS AND METHODS OF TESTING -- MERCURY FULMINATE, DETERMINATION OF THE DETRIMENTAL LIMITS OF IMPURITIES, by S. Livingston. April 1, 1949. Technical report 1722. ORD project TM3-5003B. Unclassified report.

It was found that 0.005% gold, 0.01% silver, or 0.005% gold plus 0.01% silver can be present in mercury fulminate as impurities without adversely affecting impact sensitivity, friction sensitivity, initiating efficiency, or explosion temperature. Gold and silver as impurities was found to have no effect on the stability of mercury fulminate during 6 months storage at 50°C, nor did it after its compatability with metal during such storage-temperature tests. (reh)

417 Picatinny Arsenal.

STANDARD LABORATORY PROCEDURES FOR SENSITIVITY, BRISANCE, AND STABILITY OF EXPLOSIVES, by A. J. Clear. February 1950. PA technical report 1401, rev. 1. Unclassified report.

The detailed procedures given in PA technical report no. 1401 for standard laboratory tests used for determining the sensitivity, brisance, and stability characteristics of high explosives, primer and pyrotechnic compositions, propellants and nitrocellulose have been revised. Accordingly the directions for several of the procedures have been modified wherever necessary to include details which have been found to be important. Procedures for determining the brisance and sensitivity to impact and initiation of liquid explosives, as well as the 80°C Surveillance test have been added. Other tests described are Explosion temperature, Vacuum stability at 90°C, 100°C and 120°C, and heat at 120°C and 134.5°C. Photographs and drawings of equipment used in these tests are included. (mw).

418 Picatinny Arsenal.

A STUDY OF THE ELECTRICAL AND FUNCTIONING CHARACTERISTICS OF SQUIB, ELECTRIC, H46 AND SQUIB, ELECTRIC, M1, by T. E. Petriken. July 14, 1950. Technical report 1774. ORD project TU2-1015A. Unclassified report.

On the basis of an oscillographic study, it was concluded that the H46 and M1 squibs can be functioned reliably by D.C. source voltages ranging from 2.5 to 5.0 volts, and also by the M20 rocket launcher firing mechanism within maximum functioning time limits. In the M20, the H46 required a functioning energy of 29.9 milli-joules and the M1 a functioning energy of 15.4 milli-joules. In squibs for rocket igniters, comparatively short functioning times with minimum amounts of current and energy are sought. (reh)

419 Picatinny Arsenal.

MULTIPLE DROP TOWER TEST (PRIMER-DETONATOR), by W. C. Schneider, Jr. 16 January 1951. PA manual no. 7-4. Unclassified report.

The procedure for testing primer-detonators M16A1 and T2E2 in a multiple-drop tower available at Picatinny is described in detail. The tower provides for four successful drops of 12 feet each. Detailed drawings are included of a grooved spherical fixture in which the primer-detonator is mounted for testing. (rh)

420 Picatinny Arsenal.

SURVEILLANCE STUDY OF NICKEL-ZIRCONIUM TYPE DELAY POWDER FOR M205 HAND GRENADE FUZE, by M. T. Hedges and T. J. Mahler. 17 August 1953. PA technical report 1952. Unclassified report.

Surveillance tests on M205 hand grenade fuses were made to determine the effect of the age of Nickel powder on the burning time of nickel-zirconium delay compositions. The fuses were loaded with nickel which had been aged for 0, 5 and 11 months. No correlation between age of nickel and increase in burning time of the composition after storage was observed. (vis)

421 Picatinny Arsenal.

PERFORMANCE TEST OF PULSE GENERATORS FOR FIRING TYPE T AND MK PRIMERS, by E. Eckardt. February 7, 1955. Testing Record 262. Unclassified report.

Pulse generators furnished by General Electric Company (Types A and B), Watervleit Arsenal (Types B and C), and Magnavox Company were used to test fire 420 type T and MK-15 primers. Results revealed shortcomings of the pulse generators in both design and operation. Because the output of these generators is dependent on the pressure and speed with which they are operated by the operators, it was impossible to obtain accurate, consistent, reproducible test results. No temperature cycling was attempted, since none of the generators operated satisfactorily at room temperature.

The generators tested had maximum voltages ranging from 3.5-5 volts for the Magnavox design to 7.5 for the G.E. designs

(Continued on Card 2)

and 7.0-8.2 for the Watervleit designs. Maximum pulse rise ranged from 20 m/sec (Magnavox design and Watervleit type C) to 50 m/sec for the G. E. designs, and maximum duration F to P varied with type from 20 m/sec (Magnavox) to 190 m/sec (GE type B). Some designs were fully enclosed, others had no enclosure. (reh)

422 Picatinny Arsenal.

DEVELOPMENT OF THE M36A1 ELECTRIC DETONATOR, by D. E. Seeger and D.H. Stone. August 1954. FA technical report 2032, Army project 504-01-015. ORD project TA3-5101. Unclassified report.

Since some lots of M36 electric detonators which had been accepted originally were being rejected for failure to function in the time required when retested after a five-to-seven-year ambient-storage period, work was initiated to develop a more stable detonator of this same type. An electric detonator designated as the M36A1 electric detonator was developed by replacing the mercury fulminate-nitrostarch primer charge and the shellac-coated gilding metal cup of the M36 electric detonator with a primer charge of normal lead styphnate and a cup manufactured from aluminum (Al-3).

Test results given in this report, indicated that the M36A1 detonator has better performance and storage life than the M36, and on that basis the M36A1 replaced the M36. (reh)

423 Picatinny Arsenal.

EVALUATION OF THE MODIFIED M2 DELAY ELEMENT (F-81350), by K. Weiss. November 1, 1955. Industrial Engineering Division technical report FDB-139-1. Project WD-5271-53. Unclassified report.

To simplify loading and eliminate several machining operations, all threads were eliminated from the M2 delay element and provision was made instead for assembling the primer holder to the delay holder by crimping. Approximately $.011 per unit was saved by this change. The modified design was given burning time and rough handling tests and proved generally satisfactory though some duds, attributed to poorly functioning primers, occurred. (reh)

424 Picatinny Arsenal.

EFFECTIVENESS OF SAFETY GLASS AS A SHIELD BARRICADE MATERIAL, by S. Wisneski. 1 December 1955. Industrial Engineering Division technical report PD-501-6. Unclassified report.

Tests were conducted to determine the ability of three and four ply tempered glass and standard two ply safety glass shields to protect operators engaged in the assembly of M20 detonators. It was found that the same protection afforded by the most effective safety glass could be given by Butacite cored Lucite for approximately 12% of the cost of the safety glass.

425 Picatinny Arsenal.

ADAPTATION OF A ROTARY PELLETING PRESS TO AUTOMATIC LOADING AND INSPECTION OF SMALL FUZE COMPONENTS, PARTICULARLY THE DELAY ELEMENT FOR HAND GRENADE FUZES, by R. Goldstein. January 1957. Industrial Engineering Division report no. DB-TR: 1-57.

Production rates of up to 65 min. have been attained loading delay elements of M204A2 series hand grenade fuzes.

426 Picatinny Arsenal.

INITIATOR SEALING AND SEALANTS (PRIMERS AND DETONATORS), by R. H. White. October 1957. Arsenal Operations Division technical report no. ME 600-1. Ord project no. 6030411-19-46220-00. Unclassified report.

Aluminum M20 and gilding metal M41 detonators were tested with various sealants and, for control purposes, without any sealant. Satisfactory functioning was obtained for 70 to 90% of the items tested without sealant and 99.9 to 100% of the items tested with suitable sealants.

Detonators sealed with 16 of 37 materials listed in the report as "potential sealing materials" were subjected to waterproofness and sensitivity tests and the three that gave the best results were used in the water immersion tests. Groups of 500 test items were used in the waterproofness and sensitivity tests and groups of 30 items in the water immersion tests. (reh)

427 Picatinny Arsenal. Industrial Engineering Division.
MASS PRODUCTION TECHNIQUES FOR BUTTON-TYPE ELECTRIC DETONATORS, T21E1 and T25E1; by R. Goldstein. December 1957. Technical paper DB-TP:1-57. Presented at First Meeting - Components Subcommittee, Integration Committee on Ammunition Loading. Held 27-28 March 1957, Picatinny Arsenal. Unclassified report.

A description of the development of mass production techniques for manufacturing button-type electric detonators. This particular detonator comprises three basic sub-assemblies; plug assembly, bridge and plug assembly, and the detonator cup assembly. Comparison is made of the mechanized system with the manual process and the advantages and improvements pointed out. Also given are the per unit costs for making the completed item by both the manual and the mechanized systems. (ama)

428 Picatinny Arsenal.
PROPERTIES OF EXPLOSIVES OF MILITARY INTEREST, by W. R. Tomlinson, Jr. and revised by O. E. Sheffield. April 1958. PA technical report 1740, rev. 1. Unclassified report.

A compilation of the preparation and explosive properties of 69 explosive compounds and mixtures of military interest. Among the initiators dealt with are cyanuric azide, salts of diazodinitrophenol, lead azide, lead styphnate, mercury fulminate, silver azide, tetracene, KDNBF, Silver azide and copper chlorotetrazole. (mw)

429 Picatinny Arsenal.
DETONATOR, DELAY, 15 SECOND, M1, AND 8 SECOND, M2 MALFUNCTION INVESTIGATION; by H. W. Gould. October 1958. Industrial Engineering Division technical report no. DC-TR:9-58. Unclassified report.

A report on the investigation of instantaneous functioning of M1 and M2 delay detonators. X-rays of the malfunctioned sample and several others, showed longitudinal grooves on the delay tube. When disassembled and visually inspected, the observed grooves were found to be hairline cracks. Further minute inspections disclosed that the 'crack' was a lapped joint, revealing that the lead tube was apparently made from a sheet and rolled into a tube. This lapped joint probably permitted the flash of the ignition charge to by-pass the delay element and result in an instantaneous function.

It was subsequently determined that x-rays are not a reliable means of detecting grooves or cracks unless the x-ray just happens to be taken in the correct plane. (ama).

430 Picatinny Arsenal.
CONFIRMATORY TEST OF THE M212 GRENADE FUZE CONTAINING SIFTED DETONATOR POWDER, by J. Smolnik and W. Schling. December 1959. Industrial Engineering Division report DD-TR: 1-60. Unclassified report.

A study undertaken to determine the detonator-safety of M212 Grenade Fuzes that exhibit powder sifting. Four groups of M212 Grenade Fuzes, each group containing a type of detonator defect which would tend to cause sifting of powder from the detonator, were subjected twice to both Jolt and Jumble tests. They were then fired statically with the detonator in the unarmed position. All fuzes which were tested proved to be detonator safe, and the sifting, therefore, is not considered cause for rejection of the fuze. (mw)

431 Piccard, Jean
RESISTANCE WIRE. September 12, 1933. U. S. Patent no. 1, 926, 213.

A bridge wire for blasting caps comprising gold about 58.4% and nickel about 41.6% alloyed together and drawn to the required size to have a desired electrical resistance per unit of length.

432 Pitman-Dunn Laboratories. Frankford Arsenal.
THE MICRO-QUANTITATIVE ANALYSIS OF PERCUSSION PRIMERS CONTAINING MERCURY FULMINATE, POTASSIUM CHLORATE AND ANTIMONY SULFIDE, by M. Codell and F. Verderame. September 1952 Report no. MR-520. Project no. TB3-0035. Unclassified report.

Mercury fulminate, $Hg(ONC)_2$, is determined in primer mixtures by treating the sample with 20 percent sodium thiosulfate and titrating the sodium hydroxide which is quantitatively liberated with standard hydrochloric acid.

The insoluble antimony sulfide is separated by filtration of the mixture after titration of the mercury fulminate.

Potassium chlorate, which remains in the filtrate, is prepared for analysis by adding concentrated hydrochloric acid to the filtrate and evaporating carefully to dryness. The residue is ignited at 450° C in order to volatilize sulfur and mercury salts. Potassium is precipitated as potassium dipicrylaminate which may be determined either gravimetrically or spectrophotometrically.

Potassium may also be determined by the chloroplatinate method if a separate primer sample is available. The potassium chlorate is extracted from the sample with cold distilled water, and potassium is precipitated with chloroplatinic acid after reduction of chlorate ion with concentrated hydrochloric acid.

Scope. The procedures described are satisfactory for the analysis of 20 to 30 mg of primer mix (the contents of a single small arms primer cup).

433 Pitman-Dunn Laboratories. Frankford Arsenal.
THE MICRO-QUANTITATIVE ANALYSIS OF ELECTRIC PRIMERS, by F. Verderame and M. Codell. January 1953. FA memorandum report no. 528. ORD project no. TB3-0035. Unclassified report.

A preliminary separation is made using ammonium acetate solution. The calcium silicide and any carbon and binder, if present, remain as an insoluble residue, and the lead styphnate and barium nitrate are completely extracted.

The residue is first dried and weighed. The insoluble binder and carbon are removed by igniting the residue at 600°C for one hour. Water soluble binders, such as gun arabic, are estimated by difference.

Lead styphnate is determined in the filtrate spectrophotometrically, using an aliquot portion of the filtrate.

Another portion of the filtrate is evaporated to dryness with hydrochloric and nitric acids. The residue is dissolved in 0.3 N hydrochloric acid and the lead present is removed as the sulfide.

Barium is then precipitated as the chromate. The barium chromate precipitate is dissolved in 1 N hydrochloric acid. A portion of the resulting dichromate solution is made up to volume in 0.2N hydrochloric solution and the chromate equivalent to barium nitrate is determined spectrophotometrically, using diphenyl-carbazide reagent.

This procedure has been found adequate for the analysis of 30 to 50 mg of primer mix.

434 Fitman-Dunn Laboratories Department. Frankford Arsenal.
PRELIMINARY INVESTIGATION OF FIRING PIN KINETICS AND PRIMER FUNCTION IN CARTRIDGE ACTUATED DEVICES, by H. A. Sokolwski. December 1955. FA report no. MR-616. ORD project no. 751-15-C101. Unclassified report.

It is generally believed that the nature and magnitude of the energy delivered to a percussion primer are salient factors in its functioning. Accordingly, a series of tests was conducted in which the variable factor (velocity) of the kinetic energy equation was evaluated for a given type of cartridge actuated device. In addition, tests were conducted to ascertain the prime factor which contributes to velocity and to determine the minimum firing pin velocity required to function the primer of a cartridge actuated device.

The limited tests conducted on this program indicate that the velocity of the firing pin at percussion in a cartridge actuated device of the M3 remover type, as used in existing emergency escape systems, is adequate. Further, these tests indicate that firing pin velocity is a function of shear pin material and, ultimately, the force required to shear the pin, rather than the maximum pressure behind the firing pin.

A photoelectric system, which facilitated measurement of firing pin velocity, and a primer run-down tester, which permitted propelling of the firing pin at desired velocities, were developed.

435 Pitman-Dunn Laboratories. Frankford Arsenal.
ELECTRIC IGNITION ELEMENTS T14, T14E1, T14E2, T19 AND T19E1; by S. E. Torrey and W. E. Perkins. August 1957. Memorandum report no. 655. ORD project no. TS1-15-C80. Unclassified report.

A group of bridge wire electric ignition elements has been developed and evaluated for cartridge actuated devices. These elements contain charges of priming composition in amounts established as adequate for the ignition of the cartridges for which they are intended, and all can be energized from low-voltage, nominal energy firing circuits. All elements have threaded bodies to facilitate cartridge assembly, and several elements mate with commercial electrical connectors.

436 Pitman-Dunn Laboratories Group. Frankford Arsenal.
INVESTIGATION OF LIMITING CONDITIONS FOR FUNCTIONING M3 INITIATORS AND GAS-OPERATED CAD, by C. L. Fulton. July 1958. FA report no. R-1460. Army project no. 502-06-001. ORD project no. TS1-15. Unclassified report.

A study was conducted to determine the conditions under which M3 initiators and gas-operated CAD can possibly fail to function. Investigations were conducted on gas-operated CAD to obtain data on the likelihood of failure when the pressure in the initiating gas line is at the tolerance limits of shear-pin shear. In all cases in which the shear pin was sheared, the firing pin fired the primer. Studies were also conducted in which the initiating pin of an M3 initiator was withdrawn at high velocities and at various angles from the axis of the pin.

It was concluded that both devices are reliable when operated within their design specifications; further, the M3 initiator will operate properly when its initiator pin is subjected to withdrawls up to 50 fps and/or angles up to 32° from the initiator pin axis.

437 Pitman-Dunn Laboratories. Frankford Arsenal.
DEVELOPMENT OF CARTRIDGE ACTUATED DEVICES, INITIATOR, T8 (M8), AND INITIATOR, T17 (M9), by C. S. Sterret. July 1958. Report no. R-1466. DA project no. TS1-15. OCO project no. 5S02-06-001. Unclassified report.

This report summarizes and evaluates the ballistic and mechanical development of initiator with cartridge, T8 (M8) and initiator with cartridge, T17 (M9).

The T8 initiator was designed to provide a mechanically actuated primary source of propellent gas for initiating the devices comprising the emergency escape system of high performance aircraft, whereas the T17 initiator was designed to be utilized as a pressure booster in the hose system between remotely located gas-fired cartridge actuated devices of the escape system.

438 Fitman-Dunn Laboratories. Frankford Arsenal.
KINEMATIC STUDY OF M3 AND M5 INITIATORS IN CONJUNCTION WITH M38 CARTRIDGE, by W. W. Cavell. September 1958. F. A. report R-1468; WADC TR 58-270. Army project 502-06-001. ORD project TS1-15. Unclassified report.

Mechanisms were developed to permit the rapid testing of primers and cartridges subjected to high energy application rates. It was found that rigidly held primers are not adversely affected by high pin velocities and that delivered energy continues to dominate initiation. Primers assembled into M38 type retainers exhibit certain divergent effects, but adverse results were not noted except for the energy increase requirement resulting from the addition of a sealing disc.

The extreme importance of kinetic energy in percussion primer initiation prompted an investigation into the ways and means of energy determination. Several devices and methods were considered, especially as they apply to CAD systems. For wide-range use, closely controlled copper indent analysis was found to possess the greater adaptability.

The M3 initiator was subjected to detailed kinematic analysis. Data indicated that the M3 could be expected to be marginal in operation with cartridges requiring more than 65 to 70 inch-ounces energy.

The effects of introducing aluminum firing pins into initiator complexes was considered. Results indicate that aluminum absorbs appreciably more incident energy than does steel and, hence, the energy available for initiation is reduced. Increased incident pin velocity resulting from the weight reduction does not compensate totally and, hence, the incident energy is slightly reduced in aluminum pin systems as compared to steel.

439 Fitman-Dunn Laboratories. Frankford Arsenal.
DEVELOPMENT OF A CARTRIDGE ACTUATED DEVICE, INITIATOR, DELAY, T24; by Warren Bosz. October 1958. Memorandum report no. MR-713. Army project no. 502-06-001. ORD project no. TS1-15. Unclassified report.

The T24 delay initiator, designed by Frankford Arsenal, is percussion fired and is capable of supplying the necessary gas under pressure to operate two uplocks, fire an M5 initiator, and fire a T7 drag parachute ejector in the F103 aircraft capsule-escape system. The T15 delay element, developed at Picatinny Arsenal, is used to provide the 2.25-second firing-time delay for the T24 initiator. One test model of the initiator was fabricated, but was not tested because of the cancellation of the F103 program. It was concluded that, with further development, the initiator could be used within the limits of its intended application.

440 Fitman-Dunn Laboratories. Frankford Arsenal.
FEASIBILITY AND RELIABILITY STUDIES OF ELECTRICALLY INITIATED SYSTEMS FOR CARTRIDGE ACTUATED DEVICES, by J. H. Daniels. October 1958. FA report no. R-1477. Army project no. 5S02-06-001. ORD project no. TS1-15. Unclassified report.

Research was conducted in electrically initiated cartridge actuated devices, with effort focused on the development of an electric escape system of optimum reliability and safety.

Ignition elements were developed with specific sensitivity for cartridge actuated devices. These units were designated T14, T14E1, T14E2, T14E3, T19, T19E1, and T19E2. Of these, the T14E2 has been recommended for standardization. Characteristics of these ignition elements were presented in Memorandum Report No. MR-655 by S. E. Torrey and W. E. Perkins.

441 Fitman-Dunn Laboratories. Frankford Arsenal.
DEVELOPMENT OF AN IMPROVED ELECTRIC PRIMER FOR SATISFACTORY IGNITION OF SINGLE BASE, EXTRUDED, COOL BURNING PROPELLANT IN 20MM AIRCRAFT AMMUNITION, by L. C. Long and R. E. Donnard. October 1959. FA report no. R-1479A. Army project no. 504-05-029. ORD project no. TS1-47. Unclassified report.

Describes tests to determine the cause of hesitations which occur in the M39A2 gun when 20mm ammunition armed with FAT36E7 primer is fired. The FA962 priming mixture and the rivet and button type electrode assemblies were also studied. Results indicate that the hesitations are the result of metallic slivers peeled from the base of the cartridge case as the cartridge moves through the weapon. No hesitations occurred when the M52A3 button electrode type primer assembly armed with FA962 was used. This primer is recommended for use in 20mm ammunition. (vis)

442 Plumley, H. J., R. H. F. Stresau, Jr. and F. L. Godchaux II.
DETONATOR. July 8, 1959. United States. Patent no. 2, 842, 059.

An electroresponsive detonator for use in an underwater ordnance weapon is described. Detailed specifications are presented. This detonator will fire in response to a low energy electrical impulse, yet it is so constructed that it will withstand severe impact without damage. (vis)

443 Poudreries Reunies de Belgique.
CAPSULE EXPLOSIVE ET PROCEDE POUR SA FABRICATION (EXPLOSIVE PRIMER AND PROCESS FOR ITS MANUFACTURE). 15 June 1954. Belgium patent no. 528, 984.

Describes a procedure for the manufacture of detonators whereby the explosive and initiator charges are molded separately and then joined by means of a lacquer coating, such as polyvinyl chloride. The unique advantages of this detonator are the use of plastic cup and the joining of pre-pressed pellets with a plastic binder. (mw, ama).

444 Powell, W. J., H. Skelly and A. R. Ubbelohde.
"A statistical test for percussion sensitiveness of initiators (ball and disk machine)." In ROYAL SOCIETY OF LONDON, PHILOSOPHICAL TRANSACTIONS. v. A241; 1948. pp. 287-296. Part IV of the sensitiveness of explosives.

Apparatus is described for subjecting various initiators to accurately reproducible blows, in such a way as to permit a large number of impact trials without undue labor, and thereby to determine probability of detonation for blows of graded violence.

Plots of the probability of detonation are given for various initiators, in relation to the velocity, momentum and kinetic energy of the steel drifts used for imparting the blow. It is not yet clear which of these factors is most important in determining sensitiveness to percussion.

445 Polytechnic Institute of Brooklyn.
RESEARCH ON THE PREPARATION OF NEW METALLO-AROMATIC DERIVATIVES FOR POSSIBLE USE AS IGNITION PROPAGATION REGULATORS, by Edwin S. Gould and Norman Weliky. Final report covering Oct. 1 1953 to Sept. 30 1956. Army contract no. DA 30-069-ORD-1137. Project TB2-0001 (834).

Research on organic chemistry of dicyclopentadienyliron (ferrocene) and its derivatives. These compounds containing a ferrocene nucleus were tested by various methods including chromatography and infrared spectra analysis.

This compound and its derivatives have been suggested as a motor fuel additive, combustion catalyst in home heaters and catalyst for the polymerization of olefins.

An extensive bibliography is included and suggestions for further investigation.

446 Princeton University.
"STAIRCASE" METHODS OF SENSITIVITY TESTING, by T. W. Anderson, P. J. McCarthy, and J. W. Tukey. 21 March 1946. NAVORD report 65-46. Unclassified report. Navy contract NOrd 9240.

Various "staircase" methods were studied. A staircase method is defined as any method where the severity of the next trial or group of trials is directly determined by the results of the last trial or group of trials". Both well-known methods - such as the Picatinny method, the NPF (Naval Powder Factory) inverted design, and the up and down method --and new methods -- such as the cascade, sequential, and single-explosion-plus-m-trials methods -- are covered in this comprehensive analysis. On the basis of computations of certain basic factors, seven methods were selected as recommended, each of which is described in this report, together with an operating procedure

and an appropriate analysis of results. These include: NPF, NPF inverted, large interval up and down, small interval up and down, single explosion, sequential for 10% point, and sequential for 90% point. The advantages and possible directions of future research on staircase methods are discussed. (reh)

447 Ravenna Arsenal.

"Specification for percussion primers for use in Mk2A4 primers.", by E. R. Sanders, Jr. January 11, 1955. In Integration Committee on Ammunition Loading. Initiating Components Committee. MINUTES OF THE FIRST MEETING. Held at Ravenna Arsenal. 11-12 January 1955. Unclassified report.

A discussion of the tolerances necessary to produce percussion elements for the Mk2A4 primer which will yield satisfactory sensitivity in functioning. Shown is a table listing the results from three separate test methods for each of the components tested. Also presented herein is the development of the specification for this item. (ama)

448 Remington Arms Company.

PRIMER, M52A2 ELECTRIC, by C. L. Piper and H. E. Ruppel. For the period of 1 July 1949 to 31 December 1949. Final report of phase I - progress report no. CGSF 172. Army contract no. W-11-022-ORD-11379. Unclassified report.

Reports the results of a planning study to determine the optimum form and quantity of electrical energy required to operate wireless type primers.

Development of the firing and recording circuits were highly successful. Several hundred oscillograms and recording circuits were analyzed by statistical methods with the results recorded in tables included within this report. While a great deal of work has been done and such valuable data collected, it is felt that the possibilities of these methods of investigation are far from being exhausted and that much more should be done in exploring the characteristics of M52A2 primers as well as the possibilities of experimental primer mixtures. (ama)

449 Rinkenbach, W. H.

EXPLOSIVES. n.p., n.d. Manuscript. 132 p.

A brief survey of military explosives and their applications. The preparation, manufacture, chemical and physical properties and explosive characteristics are described for the most important explosives in the following classifications: black powder, priming compositions, initiating and non-initiating high explosives, blasting explosives and propellants. The methods and apparatus used for determining explosive suitability are also summarized. (vis)

450 Robertson, J. B. and R. H. Malm.

ARMING DEVICE FOR TORPEDO EXPLODER. April 22, 1958. United States. Patent no. 2,831,430.

A gastight mechanical device designed to prevent premature torpedo explosions. This mechanism connects the primers within the torpedo to the exploder circuit after the torpedo is released, thereby eliminating the danger of explosion prior to firing. (vis)

451 Rochat, Jean.

THE ROCHAT ELECTRIC INITIATOR. May 1954. Picatinny Arsenal translation no. 27. Translated from Swiss patent no. 307005: Device for producing a spark and process for manufacturing such a device, bound in with Supplementary information on rocket electric initiator, by G. R. Loehr. Unclassified report.

A device for producing a spark for use either in igniting an explosive composition or for applications in photography. Contains two metallic electrodes for connecting to a voltage source. Electrodes are united by a colloidal metallic deposit on top of an insulated support.

Functioning times, 1 to 2 usecs, were determined by (1) elecgronic counter; (2) oscilloscope; (3) Dautriche method. Minimum energy to fire was 60 v and 0.1 uf capacitance. Serviceability proved satisfactory over a temperature range of -70° - 200°C. (ama)

452 Rolfes, H. J.

MEANS FOR SAFEGUARDING ELECTRICAL IGNITERS OF BLASTING DETONATORS AGAINST ACCIDENTAL FIRING. September 24, 1946. U. S. Patent no. 2,408,124.

An electric igniter of a blasting detonator in a combination with means by which it is safeguarded against accidental firing by electric shock or spark discharges produced respectively in, or in the vicinity of, the firing means of the igniter by atmospheric electricity, comprising a coherer mass which is in electrical cooperation with insulated conductive branches connected with each lead of the filter, said branches having bared parts surrounded by the coherer mass, a conductive grounded casing conductively connected to a conductive shell of the igniter, the coherer mass including a metal powder offering a substantially complete resistance to voltages of the magnitude used for firing the igniter and which, on being subjected to voltages substantially higher than said firing voltages, becomes locally conductive through coherer action along a path permitting the passage of the high voltage charge.

453 Rolfes, H. J.

MEANS FOR SAFEGUARDING ELECTRIC IGNITERS OF BLASTING DETONATORS AGAINST ACCIDENTAL FIRING. September 24, 1946. U. S. Patent no. 2,408,125.

Means for safeguarding the firing means of blasting detonators against static charges, including a safeguarding material of a nature to provide high resistance against current voltages for intentional firing and low resistance to higher voltages of a static charge, means for grounding said safeguarding means, electric leads for the firing means, said leads having bared parts surrounded by the safeguarding material at a distance from the firing means, and discharge points in electrical continuity with said bared parts of such leads to thereby increase the static voltage discharge through said material.

454 Rolland, G. F.

COMPOUND DETONATOR. June 10, 1947. U. S. Patent no. 2,422,043.

Initiation of PETN with diazodinitrophenol admixed with a solid explosive organic nitrate which becomes coherent when subjected to pressure has been found to result in a safer and more efficient detonator. Overall weight and volume of explosive are reduced and only a relatively small initiating charge is needed. (rh)

455 Rubenstein, Leon.

DETONATOR, FOR EXAMPLE, BLASTING DETONATOR. August 2, 1938. U. S. Patent 2,125,462.

A blasting cap wherein the base charge comprises guanyl azide picrate.

456 Rubenstein, Leon and Wilfrid Taylor.

MANUFACTURE OF FUSE HEADS FOR ELECTRICAL FIRING. May 23, 1939. U. S. Patent no. 2,159,229.

An electric blasting initiator containing an ignition composition comprising a basic lead salt of 3:5-dinitro-2-hydroxy toluene containing 47 to 62% of lead.

457 "Safe/arm explosive initiator."

In R & D. April 1, 1959. p. 10.

Based on the action of an indexing rotary solenoid, new 2152A explosive initiator, developed by Beckman & Whittley, Inc., San Carlos, Calif., is designed to the electrical and mechanical safety requirements of military type safety and arming devices. The rotary solenoid controls the position of an out-of-line disk rotor located between the initiating element and the final igniting charge.

458 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.

RADIO FREQUENCY INITIATION, by C. C. Damm. 1 December 1954. Physical Research Section memorandum no. 3. Unclassified report.

Proposes several procedures which can be used to safeguard Ordnance items from accidental initiation by radio-frequency fields. The methods outlined are 1) enclosure of entire circuit within an unperforated metallic shield, 2) development of new low sensitivity squibs and 3) use of a low sensitivity squib together with a lamp cord parallel wire connecting to the firing switch. (vis)

459 Samuel Feltman Ammunition Laboratories.

APPLICATION OF AN IMPROVED IGNITER COMPOSITION IN ELECTRIC INITIATING ELEMENTS, by B. A. Rausch. January 1955. Technical report 2120. Army project 504-03-050. Ordnance project TAI-1602. Unclassified report.

More stable, more consistent effective flash composition for use in the M1A1 squib. When this composition (39.6/32.4/18/10 potassium chlorate/lead thiocyanate/charcoal/lacquer binder) was loaded into M1A1 squib, it was found to have a more concentrated heat output, an 80° higher flame temperature and substantially improved resistance to moisture and moisture-vapor. Igniters loaded with the new mixture exhibited shorter ignition delays, improved storage stability, and more consistent freedom from malfunctions than those igniters containing standard diazodinitrophenol-type mixture. (reh)

460 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.

AN ELECTRON MICROSCOPE METHOD FOR THE DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION AND PARTICLE SHAPE OF COLLOIDAL AND BALL-MILLED LEAD AZIDE, by S. M. Kaye. February 1955. F. A. technical report 2133. Army project 505-01-0032. ORD project TAI-2707. Unclassified report.

An electron microscope method for the determination of the particle size distribution and particle shape of colloidal and ball-milled lead azide has been developed. The method involves the measurement of 200 particles of lead azide by means of the electron microscope at sufficient magnification to resolve the smaller particles (0.05 microns) present in each field. The data is assembled and the cumulative frequency is plotted against the midpoints of the statistical cells on logarithmic probability paper. The geometric mean is read directly from the graph, and the standard deviation is obtained by a simple calculation. The method, having an approximate working time of 20 hours, is considered satisfactory for the determination of the particle size distribution of colloidal and ball-milled lead azide and other materials having the same particle size distribution.

461 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.

STUDIES OF SOME DELAY COMPOSITIONS, by Burton Werbel. March 1955. Research and development lecture no. 11. Unclassified report.

The results of an investigation of the effects of variations of temperature and pressure on the burning times and burning characteristics of two delay compositions are given in this report. The delay systems studied were barium chromate/boron and barium chromate/zirconium-nickel alloy/potassium perchlorate. The general importance of delay compositions and the relative merits of gaseous and non-gaseous compositions are briefly discussed. (rh)

462 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.

INVESTIGATION OF THE NOL NO. 130 PRIMER MIXTURE, by D. E. Seeger. April 1955. F. A. technical report 2164. Army project 504-01-035. ORD project TA3-5101. Unclassified report.

In a search for a more sensitive, more efficient primer mixture for the stab-type detonators of land mines, an investigation of the Navy's NOL no. 130 primer mixture was conducted. Tests with a 1-ounce ball, obtained an all-fire height of 3 inches for M2₀ primers loaded with the NOL no. 130 mixture. The all-fire "energy" of the M2₀ primers varied from 3 1/2 inch-ounces for charges consolidated at 10,000 psi to 2 inch-ounces for charges consolidated at 60,000 psi. In lead disc perforation tests, new M47 (T32E1) detonators produced holes 0.212 inch in diameter, while M47's stored 17 months at 71°C produced 0.230 inch holes. In tests comparing NOL no. 130 and FA-100 mixtures, the NOL no. 130 was found to have an all-fire all-no-fire spread of 1 3/4 inch-ounces whereas the FA-100 had a spread of 2 1/2 inch-ounces. After 12 months at 71°C only 43 out of 50 of the

primers containing FA-100 functioned whereas 50 out of 50 primers containing NOL no. 130 functioned. T32 detonators containing as little as 5 mg of NOL no. 130 consistently perforated lead discs while even 25 mg of FA-100 did not consistently cause perforations. (reh)

463 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal. CHARACTERISTICS OF M204 HAND GRENADE FUZES LOADED WITH NICKEL-ZIRCONIUM TYPE DELAY POWDER, by D. J. Zauder and M. G. Epton. May 1955. PA technical report 2178. Army project 505-03-012. ORD project TA2-9203B. Unclassified report.

The burning time of the M204 Hand Grenade Fuze increases from the specification time of 4.5 ± 0.25 seconds to as high as 7.2 seconds after one year of storage. This fuze employs a non-gaseous delay powder containing catalytic nickel and zirconium. To eliminate this increase in burning time during storage, the powdered nickel was subjected to a dichromate treatment and to two types of heat treatment. The results of these treatments were inconclusive.

It was established, however, that the increased burning time could not be attributed to the hygroscopicity of the delay powder, its contact with a black powder relay charge or the (Continued on Card 2)

use of wet zirconium used in the manufacture of the composition.

It is concluded that the increased burning time is caused by some unknown factor in the powdered metals of the delay compositions and occurs in unpredictable fashion. (mw)

464 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal. DEVELOPMENT OF THE M47 (T32E1) DETONATOR, by D. E. Seeger. July 1955. Army project 5A045-02-021. ORD project TA1-2704. Unclassified report.

Describes the development of a new 20 mm fuse for use against aircraft. Two detonators, T32 and T32E1 involving the same metal parts were investigated. Gilding metal cups 0.321 in. long, with 0.143 in. outside diameters and 0.128 in. inside diameters were used. The T32 detonator was loaded with FA 100 primer mixture, lead azide and RDX. The T32E1 contained NOL no. 130 primer mixture. The results of firing tests against lead discs are tabulated. When fuses containing these detonators were assembled into complete rounds and fired against aluminum targets, the shell filler was initiated.

Based on the data presented, the T32E1 detonator was standardized as the M47 detonator for use in 20 mm ammunition. (vis)

465 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal. EVALUATION OF SEVERAL STYPHNATE-TYPE PRIMER COMPOSITIONS, by E. A. Rausch. August 1955. PA technical report 2220. ORD project TA3-5301. Army project 5A-04-01-015. Unclassified report.

A comparison of styphnate primer compositions and standard FA70 primer mixtures. The styphnates evaluated were: 1) Winchester 257W, 2) Western 8-4 3) Remington 50-1 and Federal 675. All of these materials were loaded into M29 percussion primers using M35 primer metal parts.

Surveillance storages tests at 160°F were carried out for 11 months. The styphnate-based compositions after this interval gave 50% functioning heights of 3.6 to 3.8 inches using a 3.96 oz. ball. Primers loaded with FA70 had values of 4.8 inches. Substituting M29 primer metal parts for the M35 parts resulted in a lowering of the functioning height to 2.2 inches.

The data presented indicates that styphnate compositions can satisfactorily replace chlorate compositions in percussion primers for large caliber ammunition.

466 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
A TECHNIQUE FOR DETERMINING THE FLAME PROPAGATION PATTERN OF ARTILLERY PRIMERS, by L. F. Marino. 22 August 1955. Physical Research Section research memorandum no. 11. Unclassified report.

Photographs show flame propagation patterns of M57 artillery primer from initiation to burn out. The illumination used in this technique is provided solely by the burning primer. (vis)

467 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
THE DEVELOPMENT OF NEW PREPARATIVE METHODS FOR NORMAL LEAD STYPHNATE, by A. C. Forsyth and Pvt. M. M. Jones. December 1955. PA technical report 2306. Army project 5A04-01-015. ORD project TA3-5101. Unclassified report.

An outline of three procedures for the preparation of normal lead styphnate all involving precipitation from an acidic solution thus insuring the absence of basic lead styphnate in the product.

Method I involves the slow addition of sodium styphnate solution to a saturated solution of lead nitrate. The second method is similar, however, the lead nitrate solution is not in excess but contains a small amount of nitric acid. In the third procedure a solution of sodium styphnate is added to a lead nitrate solution containing a large amount of nitric acid. Ammonium hydroxide solution is then added slowly and the lead styphnate precipitates out. All three methods are more rapid than the standard procedures.

The first and second ionization constants of styphnic acid and the solubility product of normal lead styphnate have been found to be 3×10^{-2}, 5×10^{-5} and 1.5×10^{-6} respectively. Surface active agents on lead styphnate precipitates tend to decrease the particle size and narrow the range of particle size distribution. (vis)

468 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
PERCUSSION-TYPE PRIMERS, by Joseph Carty. 1 February 1956. Progress report no. 1. Instrumentation report no. 486. Unclassified report.

An attempt to measure such parameters as: hangfire, time, flame duration, explosion force, flame temperature, and flame length. Results obtained, using the test equipment designed and built by the Denver Research Institute, show the maximum values of the parameters measured. M29 type primer was used for this test and a wide range of hangfire times were obtained. The maximum flame length was 2.5 in. and the minimum length was less than 1 in. Many of the minimum flame lengths occurred with a low order functioning although many of the low orders gave flame durations over 200×10^{-5} seconds. The average flame duration was not more than 50×10^{-5} seconds.

Readings for the explosion force ranged between 0.7 and 1.0. Flame temperature value of low order functions ranged from 140 to 380. (ama)

469 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
PRELIMINARY INVESTIGATION OF HMX AND MEDINA FOR USE IN DETONATORS, by D. E. Seeger, B. A. Rausch, K. G. Sheffield, and W. F. McGarry. February 1956. PA technical report 2245. Army project 5A04-01-015. ORD project TA3-5101B. Unclassified report.

With M47-type detonators as the test vehicle, various charges consisting of NOL no. 130 primer mixture, lead azide, and HMX, RDX, or MEDINA were compared in lead disc tests after storage at high temperature, at ambient temperature, under cylic conditions. Detonators containing RDX produced 0.200-0.275 inch holes; those containing HMX produced 0.211-0.282 inch homes; and those containing MEDINA produced holes averaging 0.239 inch in diameter. Incidentally, several materials -- dodecyl stearamide, octadecl stearamide, calcium stearate, calcium resinate, stearic acid, or Eastorwax -- were found useful in 2% quantities as desensitizers for the RDX and the HMX. (reh)

470 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
STABILITY OF SOME NO. 6 COMMERCIAL BLASTING CAPS, by S. M. Adelman. April 1956. PA technical report 2291. ORD project WD OAC 47001420-19-99105 Item DIC-B7. Unclassified report.

A program designed to provide information for revising the specification for commercial blasting caps. Samples of No. 6 commercial blasting caps of both the electric and non-electric types were subjected to performance tests after various periods of storage under rigorous conditions. The No. 6 caps were selected because they are most representative of all commercial blasting caps in use.

Results of these tests indicated that, with the possible exception of electric caps containing mercury fulminate-potassium chlorate/lead azide/PETN, and non-electric caps containing lead sulfocyanate-potassium chlorate-sulfur/mercury fulminate-

potassium chlorate/FETN, all groups of caps failed to cause perforation of as large a hole through lead discs and failed to crush as much sand after twenty days storage at 160°F and 85% RH as they did initially.

After 144 days storage, all blasting caps tested failed to cause perforation of the lead disc. In the brisance test only three groups crushed a measurable amount of sand. These were the two groups of caps containing the materials mentioned above, and another group of electric caps containing diazodinitrophenol-potassium chlorate/FETN. The effectiveness of the blasting caps that did crush a measurable amount of sand was decreased by as much as 95%.

471 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.

CONSOLIDATION PRESSURES OF DETONATORS, by Henry Widmann. 16 July 1956. Instrumentation Section report no. 372. Unclassified report.

Evaluates an electronic method for measuring consolidation pressures on detonators loaded on the Jones detonator loading machine. A modified punch containing two elements of a bridge serves the purpose of a new strain gage. When the load is applied to the detonator, a change in the bridge resistance due to the stresses on the punch cause a voltage to appear at the output terminals of the bridge. The bridge output is fed to an oscilloscope through an amplifier and the trace which appears on the screen is photographed with a continuous motion recording camera. Since the oscilloscope and punch are calibrated, the pressure rise time, duration of loading, and release time can be obtained from the trace. Values of peak pressure obtained ranged from 10,105 psi to 16,950 psi. A typical value of rise time was .092 sec and of release time .042 sec. The dwell time, or the interval of time required for loading was 0.284 sec.

472 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.

M47 - DETONATOR - STAB - FUNCTION - TEST, by J. S. Chiappa, and L. F. Nichols. July 1956. Surveillance Section technical memorandum no. 4. Army project no. 504-19-003. ORD project no. TS7-7002. Unclassified report.

A series of stab functioning tests of the M47 detonator were conducted to determine the depth of penetration required for reliable initiation. Functionability of the M47 detonator was evaluated using both steel and aluminum firing pins at temperatures of -65°F, 70°F and 160°F. Results show that the minimum depth of penetration, with either aluminum or steel firing pins, which would reliably initiate the M47 detonator is .045 inch. The percent functioning at this height is between 93% and 100% with 95% confidence for each temperature condition. (vis)

473 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.

PERCUSSION-TYPE PRIMERS, by Theodore Peterson. 6 August 1956. Instrumentation report no. 446. Unclassified report.

The results of tests to characterize conditioned M29 percussion primers are tabulated, using the Denver Research Primer Characterization Apparatus. The primers tested were representative of lot nos. no. 14-NOL-c-0, no. 17-Western no. 257W, no. 18 Rem. no. c4 and no. 21-WCC-2-3. Primer M29 Lot WCC-2-3 was used as standard, having a 100% functioning point at a solenoid voltage of 80 volts and a 0% functioning point at -0 volts. This primer exhibited the widest range of hangfire times, 27×10^{-5} seconds, and maximum and minimum flame lengths of 2.5 and 1 inch, respectively. (mw).

474 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.

IGNITION CHARACTERISTICS OF THE M2 SQUIB, by A. I. Rubin. August 1956. P. A. technical report 2197. Army project 504-01-011. ORD project TA3-5002, Item G. Unclassified report.

Squibs conditioned at -55°, 25°, and 50°C were tested by a new method. Direct current varying from 300 ma to 1000 ma in 100 ma steps was passed through them. Firings at each current level were recorded and, simultaneously, two independent sets of basic data were obtained -- ignition times as measured by a photocell and indicated by a Potter time interval meter, and oscillograms obtained from a 3-beam oscilloscope. Average bridge wire temperature at primary ignition time was 250°C ± 5°. Approximate burning time of the flash charge of the squib in air was 50 milliseconds. (reh)

475 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.

EVALUATION OF ELECTRIC PYROSWITCHES, by E. L. Gibbs. September 1956. Instrumentation Section report no. 430-57. Unclassified report.

A total of 95 pyroswitches were tested for firing voltage and functioning time before and after subjection to immersion, transportation vibration, temperature and humidity cycling for a period of 28 days, low temperature and deceleration tests. The functioning time varied from 5 to 35 milliseconds. A firing voltage of 55 volts was used for all the tests except for the Bruceton test in which the voltage varied from 15 to 25 volts. Results are tabulated and indicate little variation in the functioning time for all the switches tested. (mw)

476 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.

INVESTIGATION OF 95/5 LEAD AZIDE/TETRACENE FOR USE IN MINIATURE DETONATORS, by R. L. Wagner and K. G. Sheffield. January 1957. High Explosives Section report 5. ORD project TAI-3702. Unclassified report.

Describes the sensitivity, loading density and storage characteristics of M26 percussion primers loaded with 95/5 dextrinated lead azide/tetracene and 95/5 polyvinylalcohol lead azide/tetracene. Results show that lead azide and tetracene in this ratio are not compatable at 71°C. The tetracene content after 4 months storage was found to be 0.2% Malfunction was also observed. (vis)

477 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.

T106E1 (M75) PERCUSSION-ELECTRIC PRIMER, by W. J. Puzia. February 1957. Army project 5A04-03-058. ORD project TAI-2040. PA notes on development type materiel no. 47. Unclassified report.

The T106E1 (M75) percussion-electric primer, to be used for bag-loaded weapons, consists of a primer body, a TZ1 percussion-electric ignition element containing an M37 percussion unit, and a primer charge of 18 grains of grade A3 black powder. For reliable electrical functioning, an energy of 200,000 ergs is required.

Primer assembly specifications are included. (mw)

478 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.

PA-101 PRIMER MIXTURE FOR INITIATING DELAY COMPOSITIONS, by T. W. Stevens and K. G. Sheffield. April 1957. High Explosives Section report no. 10. Unclassified report.

Describes the development of a primer mixture (PA-101) that will initiate Type II zirconium - nickel alloy delay compositions. This mixture consists of basic lead styphnate - 53%, barium nitrate - 22%, antimony sulfide - 10%, tetracene - 5% and aluminum - 10%. Primers loaded with this mixture produced an impulse and gas volume of 1.41 inches and 0.26 milliliters, respectively, as compared to 2.49 inches and 0.26 milliliters for similar primers utilizing the chlorate-type WCC-793 mix. Primers containing each mix were loaded into M204A2 hand grenade fuzes which were then tested for burning time at extreme temperatures. The standard deviations in burning time for the PA-101 mix were 0.13, 0.12 and 0.10 second at -65°F, ambient temperature, and 160°F, respectively; those for the standard commercial mix (WCC-793) were 0.17, 0.10, and 0.11 second. Storage stability studies were not conducted. (mw)

479 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.

EVALUATION AND CHARACTERISTICS OF THE T88 DETONATOR, by R. Michael. 24 April 1957. Instrumentation report no. 447-57. Unclassified report.

An evaluation of the T88 detonator using the Franklin Institute Laboratory Initiator Test Set. A graphic illustration of the results of the Bruceton Staircase Test is included. (mw)

480 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.

DEVELOPMENT OF A MODIFIED M40 ARTILLERY PRIMER HEAD FOR INITIATING LOW ENERGY DETONATING HEAD, by R. L. Wagner. July 1957. Explosives Development Section report no. 15. ORD project no. TAI-5025. Unclassified report.

A practical initiating device for LEDC was developed by modifying a standard M40 primer head to contain a lead azide relay and a portion of the LEDC. In test firings with two sizes of dextrinated lead azide relay (50 mg. in a column .08 + .01" in diameter and .21-.01" high, and 35 mg. in a column .08 + .01" in diameter and .11 - .01" high) the new initiator performed satisfactorily causing detonation of the LEDC in all cases. When tested without the lead azide relay, the initiator failed to detonate the LEDC. (reh)

481 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
PROPOSED FINAL ENGINEERING TEST PROGRAM FOR FIRING DEVICE, R. R. TORPEDO TYPE, T42, by F. B. Sando. October 1957. Ammunition Development Laboratory B technical memorandum no. 42B13. ORD project no. TS1-400 (TA3-530, RR) Unclassified report.

Describes a study performed in order to effectively evaluate the design and assure an acceptable item. Development engineering tests have disclosed that the device under the wheels of a locomotive generates voltages ranging from 1,000 to 2,000 and develops sufficient energy to reliably initiate the T39 spark gap detonator. (ama).

482 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
PRELIMINARY INVESTIGATION OF COPPER CHLORO-TETRAZOLE FOR USE IN DETONATORS, by R. L. Wagner. October 1957. Explosives Development Section report no. 17. ORD TAI-2707 BK. Unclassified report.

The object of this work was to determine the stab sensitivity and output characteristics of copper chlorotetrazole. It was found that the stab sensitivity of this material increases with consolidation pressure. It is theorized that a progressive change takes place which causes copper chlorotetrazole to deflagrate or explode low order as loading pressure is increased. It may, therefore, be similar to mercury fulminate in this respect.

Booster initiation tests of M46 detonator parts loaded with this explosive indicates sufficient power to initiate a booster containing RDX. The loading characteristics of the copper chloratetrazole used was extremely poor. This material was very fine and powdery and perhaps a more free-flowing material would be more suitable for production loading. (ama).

483 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
INVESTIGATION OF ALUMINUM AND STAINLESS STEEL M47 DETONATOR CUPS AND DISCS, by K. G. Sheffield, R. L. Wagner, and B. A. Rausch. February 1958. Explosives Development Section report 21. ORD project TA3-5101. Unclassified report.

Detonator cups of aluminum or steel (instead of the gilding metal previously used) were evaluated. Stainless steel cups were tested with .002" and .0006" stainless steel detonator discs, and aluminum cups with .002" discs. All cups were sealed with standard sealants. The stainless steel cups with .0006" sealing discs gave best output, but functioned low order after storage. This was attributed to leakage of moisture and development of a new sealant was recommended. (reh)

484 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
INVESTIGATION OF METHODS FOR THE ANALYSIS OF LEAD AZIDE, by Roscoe Croom and Frank Fristera. March 1958. I A technical report 248e. Unclassified report.

A comparison of the gasometric, British (ERDE) and distillation-titration methods for lead azide analysis. Results show that the gasometric procedure is most desirable while the ERDE is least desirable. The titration method is inaccurate when used for the analysis of azides containing additives. A modified titration method which provides for carbon dioxide removal is outlined. It is recommended that this modification be included in Specification MIL-L-3065 as an alternate method. (vis)

485 Samuel Feltman Ammunition Laboratories. (Picatinny Arsenal).
DEVELOPMENT SUMMARY AND PROPOSED ENGINEERING TEST PROGRAM FOR LIGHTER, FUZE, WEATHERPROOF, T2, by J. R. Messick. May 1958. Ammunition Development Laboratory B technical memorandum no. 83B24. Unclassified report.

The effort put forth resulted in the development of an improved fuse lighter made entirely of nylon except for the firing system. Vents are provided between the firing chamber and the upper body to relieve the pressure build-up caused by the burning primer and fuse thus preventing fuse "blow-outs". Rubber seals are used at both ends of the lighter to permit firing underwater. The unit also provides a quick reset feature permitting the user to quickly reset and refire the lighter in case of a suspected misfire.

486 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.
EVALUATION OF ELECTRIC PYROSWITCHES, by L. N. Chetti. 29 May 1958. Instrumentation Section report no. 1784-57. Unclassified report.

A tabulation of the results of tests to determine the functioning time of Electronic Pyroswitches after subjection to JAN cycling, water immersion and hot temperature tests. A firing voltage of 55 volts was used for all the tests; the functioning time varying from 2 to 100 milliseconds. (mw)

487 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.
MECHANICALLY INDUCED AND RADIATION INDUCED DEFORMATION FAULTS IN SODIUM AZIDE, by Saul Fraunhof and D. T. Keating. May 1958. PA technical report 2483. Army project 5A12-15-005. ORD project TA2-5005. Unclassified report.

Sodium azide crystals, after subjection to mechanical force (grinding), gamma irradiation, and reactor (pile) irradiation were examined by x-ray diffraction techniques to determine whether any change in the crystalline structure had occured. Stacking faults were introduced by grinding and irradiation. Signs of decomposition - lowering of the ignition temperature, discoloration, and lattice contraction - were present in irradiated samples. Some faults were removed by annealing, but a significant fraction were stable, even at ignition temperature. In addition to stacking faults, certain other causes of strain - interstitials and vacancies, decomposed azide molecules, and interstitial nitrogen - appear to be present.

488 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.
THE DEHYDRATION OF LEAD STYPHNATE MONOHYDRATE, by T. B. Flanagan. May 1958. PA technical report 2514. Army project 503-05-021. ORD project TB3-0115. Unclassified report.

The dehydration of lead styphnate was studied in vacuo from 100° - 130°C and found to dehydrate at a constant rate over a large range. The activation energy for the dehydration is 21.7 kcal/mole. The influence of water vapor was examined at 120°C over a range of pressures and a maximum appears in the curve of rate versus water vapor pressure. Material dehydrated at the maximum was found to differ quite markedly from material dehydrated in vacuo. The color of the former was yellow-orange, of the latter brick red. The rate of rehydration is much slower, and the subsequent decomposition is different. (mw)

489 Samuel Feltman Ammunition Laboratories. (Picatinny Arsenal).
THEORETICAL CALCULATION OF R-F ENERGY RECEIVED FROM THE AFS/20E RADAR BY A "T24E1" INDICATOR SIMULATING THE T24E1 ELECTRIC DETONATOR, by D. N. Shaw. August 1958. Explosive Research Section report no. 38. Unclassified report.

Table I of Reference I contains results of exposure of both attenuated and unattenuated "T24E1" indicators to 2880 megacycle radiation from the AFS/20E radar. In general, it is shown that all unattenuated indicators fired when initially exposed to r-f, whereas attenuated indicators required considerably greater amounts of r-f power for firing, and two attenuated indicators withstood all exposure tests without firing. Power applied to the indicators was varied by changing the distance between the radar antenna and the indicators. Unattenuated indicators were fired with lead wires shorted, as well as with lead wires formed as dipoles.

INATOR. Card 2.

This report contains an approximate calculation of the r-f energy received by indicators which were tested with lead wires formed as dipoles. In addition, the attenuation needed to prevent firing by this particular radar is computed. The r-f energy received is compared to the normal electrical sensitivity of the indicator, and the required attenuation is compared to the actual attenuation available in the prototypes tested.

Certain assumptions of the physical characteristics and the functioning sensitivity of the indicator are necessary to complete the foregoing information. Accordingly, a theoretical model of the T24E1 indicator is established in Paragraph II. All calculations are based on this model. The sections "Sources of Error" and "Theoretical Discussion" review the probable effect of the assumptions and reasons for their use.

490 Samuel Feltman Ammunition Laboratories, Picatinny Arsenal.
DETONATOR, ELECTRIC, T24E1, by D. W. Owens. 5 December 1958. Instrumentation Section report no. 114-58. Unclassified report.

Tabulation of results of functioning tests (5 mfd capacitor, 4.5 volts) on 250 T24E1 detonators after subjection to 28 day JAN test with and without 95% relative humidity test, and water immersion.

Conclusions: 1) Water conditioning in immersion test had no effect on firing and 2) Humidity affects the reliability of the T24E1 detonator. (mw)

491 Samuel Feltman Ammunition Laboratories. Picatinny Arsenal.
EVALUATION OF T7E1 DIMPLE MOTORS, by C. Bandstra. 9 March 1959. Instrumentation Section report no. 293-59. Unclassified report.

Two hundred and fifty T7E1 Dimple Motors were subjected to the Salt Spray test, 20,000 G Shock test, Jolt test, etc., and then were evaluated using the Franklin Institute Laboratory Initiator Test Set. Results are tabulated.

Satisfactory performance requires a functioning time between 10 and 50 milliseconds and a minimum movement of 0.1 inch against a load of 8 pounds. (mw)

492 Samuel Feltman Ammunition Laboratories. (Picatinny Arsenal).
ENGINEERING TEST REPORT ON LIGHTER, FUSE, WEATHERPROOF, T2, by R. A. Resch. March 1959. Missile Warhead & Special Projects Laboratory technical memorandum no. 158B52. ORD project no. TS1-400. Unclassified report.

Essentially, this report describes the development of a mechanism to effectively and consistently light Safety Fuse, M700 in air or under water. The lighter is made of nylon except for the firing system. Vents are provided to prevent blow-outs, and rubber seals at each end permit firing underwater. There is also a quick reset feature permitting quick refiring in case of a suspected misfire. (ama).

493 Sandia Corporation.
EXPLODING WIRE PHENOMENA: A BIBLIOGRAPHY, by W. H. Richardson. November 1958. SCR report no. 53. Contract no. (AEC) AT-(29-1)-789. Unclassified report.

This survey of the literature on Exploding-Wire Phenomena covers all forms of reference material - books, periodicals, and reports - published through April 1958. It includes early material on basic physics and properties of materials. (ama)

494 Scherrer, G. H.
DETONATOR. October 21, 1947. U.S. patent no. 2,429,490.

This patent describes an electric firing device which has a reliable short-time delay, has a very low ignition energy requirement, is waterproof and rugged, and has small overall dimensions. These characteristics are achieved by emphasizing the tightness of all joints (pressure fits tight enough to slightly bulge the outer case are used); by placing a heat-conducting element, in the form of a thin metallic disc, between the heating charge and the detonating charge; and by using an ignition assembly having a very low ignition energy requirement. Tightness of fit between the heating charge, the metallic disc, and the detonating charge is further enhanced by tight-fitted annular washerlike members placed above and below the metallic disc. These washers also make for more efficient ignition of the detonating charge by channeling the heat from the heating charge. (rb)

495 Seavy, F. R.
BLASTING CAP. May 6, 1947. U. S. patent no. 2,420,201.

A blasting cap having a shell, an explosive initiating charge therein, and a base charge of secondary explosive in contact with the initiating charge, the said base charge being composed of a series of preformed tablets of explosive wherein each tablet has a substantially uniform high density, the top and bottom tablets are perforated so as to have the form of annular rings, and at least one solid tablet is disposed between the said perforated tablets, the initiating charge being disposed within the top perforation of the base charge.

496 Seavey, F. R.
BLASTING CAPS. October 23, 1956. U.S. Patent no. 2,767,655.

This invention relates to explosive initiators and particularly to detonators of the type employed for initiating the explosion of larger charges of explosives as in military or blasting operations.

497 Shilling, N. A.

"Explosive substances and loading of ammunition (vzryvchatyie veshchestva i snariazheniye boyepripasov)." Oborongiz, Moscow. 1946.

A Russian text on explosives and the use of these explosives in ammunition. The following list of items have been discussed in some detail within this book: definition and classification of explosives; characteristics of initiating agents; cartridge type percussion caps; weights of charges of percussion composition and amounts of pressure used in pressing in the cartridge percussion caps; schematic construction of primer caps and their basic characteristics; detonator caps; the electric primer and electric detonator; characteristics of the explosives and other materials used in loading; etc. (ama) =

498 Signal Corps. Engineering Laboratories.

FINAL REPORT ON THE EFFECT OF RADIO WAVES ON ELECTRICAL BLASTING, by F. J. Triolo and R. Bruckman. August 1953. Technical memorandum no. MI-1525. Project (S. C.) no. 132A. DA project no. 3-99-17-021. Unclassified report.

The purpose of this work was to investigate the potentialities for premature detonation of typical electrical blasting circuits by radio transmission. Also, to make recommendations for proper instruction of field personnel to minimize the danger of premature detonation of electrical blasting circuits under field conditions.

Two typical electrical blasting configurations, submitted by ERDL for tests have been investigated over the frequency range from 2.55 mcs. The critical or resonant frequencies, azimuth of maximum radiation or pick-up and antenna input power versus distance for each critical frequency at its azimuth of maximum radiation was determined for both circuit configurations.

It was found that the hazard of premature detonations is greatest at the lowest resonant frequency and lower frequencies and decreases considerably with increase in frequency above the lowest resonant frequency. (ama)

499 Silas Mason Company. Iowa Ordnance Plant.

A study of reactions occurring in a mixture of lead thiocyanate, potassium chlorate, and water.", by G. E. Frazer and L. R. Rothstein. In Integration Committee on Ammunition Loading. Initiating Components Committee. MINUTES OF THE FIRST MEETING. Held at Ravenna Arsenal. 11-12 January 1955. Unclassified report.

The wet primer mix explosions are attributed by the authors to an easily reproduced reaction (Reaction A) of lead thiocyanate, potassium chlorate, and water to form sulfates, cyanides, chlorides, and polymers of thiocyanic acid.

This reaction is initiated at relatively low temperatures (100°C), but liberates much heat and the secondary rise in temperature undoubtedly initiates other side reactions such as the spontaneous decomposition of potassium chlorate to form noxious chlorine-oxygen gases such as in reaction B.

[illegible] indicates that the formation of acid is essential for this reaction to take place. This is based upon the following observations:

A. Lead thiocyanate and potassium chlorate when mixed dry can be heated to temperatures up to over 200°C before any reaction between them takes place.

B. Lead thiocyanate mixed with pure distilled water, regardless of the source, had a pH in the neighborhood of 4.7 due to the hydrolysis of lead thiocyanate. Potassium thiocyanate, for example, does not hydrolyze to form acidic solutions (the water remaining neutral) and when it is substituted for lead thiocyanate under these same conditions no reaction occurs. However, a small amount of acid is added to a mixture of potassium thiocyanate, potassium chlorate, and water, the type of reaction described previously occurs within 30 seconds.

C. Finally, it has been demonstrated that the presence of a small amount of an anti-acid (sodium hydroxide and sodium bicarbonate were tried) no reaction occurs between lead thiocyanate and potassium chlorate even though all the other conditions, presence of water, temperature, time, etc., were the same as in those cases where reactions occurred.

800 Smith, R. L.

SQUIB. August 6, 1957. U. S. Patent no. 2,801,585.

Describes a squib having substantially no brisance for use in igniting the grain of a solid propellant rocket. It is hermetically sealed, has a relatively long shelf life (5 years) and may be immersed in water numerous times without adverse effects. The functioning time is from 0.4 to 0.8 millisecond over the required temperature range of -65°F to +165°F. (mwi

801 Smith, J. B., F. R. Seavey and C. A. Taylor.

DELAY DETONATOR. October 11, 1938. U. S. Patent no. 2,133,119.

A delay detonator comprising in combination, a housing, removable delay charge in said housing and a series of members selectively cooperating with said housing to provide a gas cooling chamber having a volume coordinated with the delay charge.

802 Spaeth, C. F.

IGNITION COMPOSITION. December 18, 1934. U. S. Patent no. 1,984,846.

An ignition material as the top charge in a composition electric blasting cap, containing a suitable base charge and a primary charge of lead azide, said ignition material comprising tetramethylene diperoxide dicarbamide.

803 Spaeth, C. F.

IGNITION COMPOSITION. July 9, 1935. U. S. Patent no. 2,007,223.

An ignition composition as the top charge in an electric blasting cap containing a base charge of a secondary detonating compound, said ignition composition comprising smokeless powder impregnated with nitroglycerin and potassium chlorate and having the composition 40 to 80% smokeless powder, 5 to 35% nitroglycerin and 2 to 25% potassium chlorate.

804 Stadler, Robert.

Researches on the analysis and explosive properties of silver acetylides. In ZEIT. FUR DAS GESAMMTE SCHIESS-UND SPRENGSTOFFWESEN. November 1938. pp 302-305. Translated by T. H. Norton.

In reporting the work on C_2Ag_2 compounds, considerable results and data are described concerning the gaseous products resulting in the explosion of these compounds. Also given are the methods for preparing these compounds.

New data presented includes the measurement of the velocity of detonation of silver acetylide, load densities, lead block tests, sand test, and ignition tests. (ama)

805 Stanford Research Institute.

INTERACTION OF ELECTRON AND ION BEAMS WITH METASTABLE SUBSTANCES, by C. J. Cook and H. J. Eding. 11 December 1957 to January 22, 1959. Quarterly progress reports nos. 1 thru 3 and final report. Army contract no. DA-44-009-ENG-342c. Army project no. 8-07-304. Unclassified reports.

Describes research on the growth of alpha lead azide crystals and the interaction of slow electrons with surfaces of lead azide resulting in the improvement of the vacuum trapping technique and electron source. The ratio of available beam time to total beam time was increased from 0.2 to 0.9. A hydrazoic acid diffusion method for the preparation of lead azide which is used in crystal growing solutions was developed. Crystal growth was accomplished using the following apparatus: (1) controlled cooling and (2) micro crystallizer. Lead azide crystals obtained in this manner were colorless, transparent and had no defects.

Interaction of electrons with alkali halides is discussed. Data on the absorption coefficient for the action of slow electrons on KCl is presented. Results indicate that the absorption coefficient is a function of impact energy. This coefficient changes when the surface of KCl has been exposed to oil vapors. An apparatus which will permit crystal cleavage and isolation of surface contaminant effects is presently being designed. (vis)

506 Stanford Research Institute.

ELECTRICAL INITIATION OF INSENSITIVE EXPLOSIVES, by D. B. Moore and G. M. Muller. November 18, 1953. Poulter Laboratories technical report no. 0[illegible]. Unclassified report.

Initiation of reaction in powdered RDX has been consistently achieved by the electrical explosion of a 1.4 inch long, 4 mil diameter copper bridgewire with a stored energy of 4.5 joules, larger energies being required for either thicker or thinner wires. Dependence of minimum initiation energy on the characteristics of the firing circuit is likely, however.

Powdered RDX has also been initiated by the simultaneous electric explosion of two bridgewires.

These results establish the feasibility of constructing a reliable electrical initiator not containing any explosive more sensitive than powdered unwaxed RDX. Whether electrical initiation of explosives like composition B without the intermediary use of RDX can be achieved in a practically usable device remains an open question. (ama).

507 Stettbacher, A.

Initiating explosives. In NITROCELLULOSE. (1940) no. 12, pp 227-[illegible]. Picatinny Arsenal translation no. 43. Translated by U.S. Joint Publications Research Service. Unclassified report.

Silver acetylide produced by filtering and drying the precipitate obtained by passing purified acetylene through a nitric acid-silver nitrate solution was compared with silver acetylide produced by other processes and with other initiating explosives.

This product is reported (by R. Stadler) to have a higher explosion heat than silver acetylide deposited from a neutral solution (485 cal/kg as against 400 cal/kg). In this investigation its initiating pressure was found to be not quite equal to that of pure lead azide and substantially inferior to that of mercury fulminate. Contrary to earlier reports, it appeared to be stable in storage.

A section describes a unique method of hypergolic ignition for [illegible] tests. Glycerine is dropped onto an oxidizing permanganate-chlorate mix which spontaneously initiates the explosive in the test cup. (ama)

508 [illegible], R. S.

[illegible] MACHINE. August 30, 1949. U.S. Patent no. [illegible]

A welding assembly comprising a plurality of firing devices, a manually operable A.C. dynamo, a condenser connected in the output circuit of said dynamo to receive electrical energy therefrom, a rectifier in one of the connections between said dynamo and said condenser to provide unidirectional charging means for said condenser and to prevent leakage of said electrical energy from said condenser back to the dynamo, output connections from said condenser to said firing devices, and a voltage control tube in one of said output connections, said voltage control tube passing current of firing value to all of said firing devices simultaneously.

509 Street, H. W. L.

TESTING MEANS FOR A PRIMER. January 15, 1957. United States. Patent no. 2,777,323.

Describes an electronic timing apparatus that can be used to determine the sensitivity of an explosive charge. Improper functioning of the contact element normally employed to signal this moment of impact is eliminated by this mechanism because there is no mechanical restraint placed upon the element. The timer is, therefore, started instantaneously at the moment of impact. (vis)

510 Stresau, R. H.

"Explosive items as components of weapons systems." In CHAPTER II OF EXPLOSIVE CHARGE DESIGN. Army Handbook no. ORDP 20-178.

Draft copy published as:
Armour Research Foundation.
EXPLOSIVE ITEMS AS COMPONENTS OF WEAPON SYSTEMS, by R. H. Stresau. June 18, 1954. Pamphlet no. 24-03-00. Army contract no. DA-11-124-ORD-[illegible]. Unclassified report.

All of the various elements of explosive trains - including main bursting charges, boosters, detonators, relays, primers, and delay elements - are discussed in terms of major principles and other considerations which affect their design. Also dealt with are such related items as actuators, explosive switches and destructors.

Safety and reliability as a limitation on design is treated in detail, and environmental factors are considered under the following headings: "Ammunition Items as Vehicles", "Ammunition Items as Structures", "Ammunition Items as Mechanical Devices", and "Ammunition Items as Electrical Systems."

A section on aerodynamic heating describes a simple method for determining how serious such heating is for any particular explosive component or item. The pro and con of standardization is also discussed. (reh)

511 Stettbacher, Alfred.

Lead trinitroresorcinate. In NITROCELLULOSE nos. 8-10 1935 & nos. 1, 2, 4, 5, 1938. A translation from the Western Cartridge Company by J. Fleischer; dated January 13, 1938. Excerpts from pamphlet "Fortschrittliche Spregtechnik", by Dr. Alfred Stettbacher. Lehmann, Berlin. 1937. Unclassified report.

A review of the state of the art up to the date of publication. This description of the methods of preparation, purification, properties, and explosivity as compared to other well known initiators, is advance the spirit of research in the science of explosives as opposed to monopoly and adaptation.

The author states that this explosive is easily prepared and available to anyone who has control over his mind and hand.

Most important is the detailed information on the preparation of lead styphnate. (ama)

512 Sussan, G. E.

IGNITION COMPOSITION. January 7, 1936. U. S. patent no. 2,026,208.

An ignition composition comprising 80 to 95% zirconium and 20 to 5% of an easily ignitable lead salt of a nitrophenol.

513 Suzuki, Akira. (Naval Air Technical Branch - Tokyo Imperial University)

CRYSTALLINE STRUCTURE AND EXPLOSIBILITY OF FULMINATE OF MERCURY. 10 April 1944. A study of initiators - 3rd report. A translation. AGAIRO, Wright-Patterson Air Force Base. Microfilm no. Rc-1870E. Unclassified report.

The crystalline structure of mercury fulminate was analysed in order to determine the processes of thermal decomposition and explosion of mercury fulminate as well as its structural formulas. The explosion phenomena of initiators is discussed and the test apparatus and procedure are described. It was found that the mercury fulminate crystal contains four molecules and belongs to the orthorhombic system, the axis being a=7.71A°, b=5.48A°, c=10.43A° in length. The space group belongs to D_{2h}^{14}, and mercury forms a face-centered lattice. A rational picture is drawn of the thermal decomposition of the mechanism of explosion of mercury fulminate based on its crystalline structure.

514 Taylor, G. B.

"High explosives primers." In CANADIAN CHEMISTRY AND PROCESS INDUSTRIES. v. 2: 1918. pp 7-8.

Traces early development of high explosive primers as investigated by Nobel, Abel, Wohler, Will and Lenze. Starting with the use of black powder, development is followed on through such initiatory explosives as: mercury fulminate, lead azide, potassium chlorate type mixtures, silver azide, etc. Also described is the construction of a typical detonator for blasting explosives which consists of a drawn copper shell 5 to 10 mm in diameter and 20 mm long, filled with 1 - 2 gm mercury fulminate or its mixtures with potassium chlorate and then perhaps having a base charge of tetryl.

Some attempts are made to discuss the theory of detonation for such explosive mixtures. (ama)

515 Taylor, W. and C. R. L. Hall.

"Firing characteristics of low-tension electric detonators." In THE COLLIERY GUARDIAN. v. 176, no. 4554. April 23, 1948. pp 547-551. Abstract of a paper read before the North of England Institute of Mining and Mechanical Engineers at Newcastle on April 10, 1948.

Described is a typical British commercial electric detonator wherein the explosive and ignition system are enclosed in a thin-walled copper or aluminum tube. Explosive is capable of immediate ignition from a spit of flame and exploding with sufficient violence to shatter the tube and detonate the main charge. Base charge is Tetryl and priming charge is a mixture of lead azide, lead styphnate and flake aluminum. The electric fuse-head which supplies the spit of flame is a bridge-wire type squib with an igniting composition of lead mononitroresorcinate potassium chlorate/charcoal (ama)

516 Taylor, Wilfred and Maldwyn Jones.

MANUFACTURE OF ELECTRIC DETONATORS. October 5, 1943. U. S. Patent no. 2,331,007.

An electric detonator in which the insulated electric conductors leading to the electric initiating element are twisted together and pass through a resilient electric plug comprising vulcanized polymerized 2-chloro-butadiene-1:3 crimped into the mouth of the charged detonator tube.

517 Texas. University. Defense Research Laboratory.

THE THERMAL DECOMPOSITION AND INITIATION PROPERTIES OF ALPHA LEAD AZIDES, by O. H. Hill. June 1955 - July 1957. Monthly Progress Letters and Final Technical Report. Project no. 8-07-02-004. Contract (Army) DA-44-009-ENG-2566. Unclassified reports.

The research program was concerned primarily with the study of the thermal decomposition and the onset of thermal initiation in alpha lead azide. In addition, minor effort was expended in studies relating to the non-aqueous manufacture of lead azide and the reproduction of an experiment by Kallmen and Schrenkler in which typical explosives were reportedly initiated by ion bombardment. This experiment met with little success and further effort was directed towards the more productive studies of thermal decomposition of lead azide in vacuum. There resulted a development of a particular mechanism for the decomposition process which is an extension of and consistent with that developed earlier for the thermal decomposition of barium azide. (ama)

518 Turek, C.

2, 4, 6-Trinitro-1, 3, 5-triazidobenzene: a new priming explosive. In CHIMIE ET INDUSTRIE. v. 26. 1931. pp. 781-794. Picatinny Arsenal translation no. 70. February 1960.

Describes the preparation, manufacture, explosive and thermal characteristics of the subject primer. A comparison of its priming qualities with mercury fulminate is presented. The results indicate that 2, 4, 6-trinitro- 1, 3, 5-triazidobenzene is superior. The main characteristics of this priming explosive are: (1) extraordinary priming power; (2) resistance toward water and humidity; (3) inflammability; (4) good stability; (5) low sensitiveness to friction and shock; (6) complete lack of sensitivity to friction when wet; (7) indifference toward metals and acid vapors; (8) ease of handling and (9) the low cost of the priming lead required for a detonator. (ama)

519 Tweed, T. B.

Electric detonators." In ORDNANCE. v. 44, no. 238. 1960. pp 453-455.

Describes the construction, explosive charge, firing characteristics and uses of the following electric detonators: M36, M48, M54, T29E1, T44, T45, T52, T23 and T39.

820 Ubbelohde, A. R.

"The onset of detonation in the sensitiveness of explosives." In ROYAL SOCIETY OF LONDON, PHILOSOPHICAL TRANSACTIONS. V. A241; 1948. pp. 198-203. Part I of The sensitiveness of explosives.

The ease with which explosives detonate on receiving a sharp blow or shock is of practical importance in determining manufacturing precautions and safety in handling, and also in deciding what initiators can be used. Physical tests on sensitiveness have hitherto imitated either manufacturing or service conditions as closely as possible. With any one physical test, such as that of the impact machine, it is possible to arrange explosives in a scale of sensitiveness. The order of sensitiveness in a scale determined in any one way may be quite different from the order determined in other ways, but owing to the empirical nature of the tests it is often difficult to explain why anomalies occur. Results in accordance with each other are, however, obtained in many cases.

Progress in synthetic organic chemistry has increased the range of possible explosives to such an extent that some more scientific information on sensitiveness would be most useful in orienting future developments. Various developments in the experimental knowledge on the subject are discussed in the following sections: the mechanism of initiation of detonation, critical conditions for the propagation of detonation, special activation processes in solid explosives, cooperative build-up of detonation; and theory of heat sensitiveness of initiators.

821 Ubbelohde, A. R.

"Delay to ignition and its temperature coefficient." In ROYAL SOCIETY OF LONDON, PHILOSOPHICAL TRANSACTIONS. v. A241; 1948. pp. 204-222. Part II, section 2, of The sensitiveness of explosives.

Details are given of a method of determining the delay to ignition at various temperatures, for initiators. The heat sensitiveness of an initiator can be characterized by an equation $\log Y = E/(57T) + B$, where Y is the induction period before ignition, E is the activation energy of the physico-chemical process controlling it, in Kcal. mol., and B is constant. T is the absolute temperature.

Values of E and B are listed for lead azide, mercury fulminate, basic lead dinitroresorcinate, lead styphnate, and barium styphnate. From an extrapolation, ignition temperatures have been calculated corresponding with delays of 10^{-4} and 10^{-5} sec., to line these up with certain aspects of sensitiveness and detonation.

Experiments are described which show that initiators such as lead azide can be more or less permanently sensitized by heat treatment and by photochemical action.

Experiments are also described which show the failure to detonate below a certain temperature, and on the ignition times, of lead azide, lead styphnate and mercury fulminate. The behaviour of mixed initiators, and of simple initiators admixed with inert diluents, has also been investigated. The results show that detonation is built up from the cooperation of a number of centres of reactivity.

It is shown that in the mixed composition 'A. S. A.' the lead styphnate plays the predominant role in the heat sensitiveness, improving the thermal pick-up and lessening the tendency of lead azide to fail to detonate on heating.

X-ray measurements and determinations of the heat sensitiveness are described for Service and dextrin azides. It is shown that the grains of Service azide consist largely of single crystals, whereas the grains of dextrinated azide each contain about 10 crystallites. The lattice crystal structure in the two azides is the same.

With the samples investigated, the activation energy controlling the length of the induction period is about 41.3 Kcal/mol. for Service azide and 28.4 Kcal/mol. for dextrinated azide. The larger difference between these values is correlated with the difference in initiating power of the two types of azide.

Sensitiveness to heat, percussion, and friction are compared for Service and dextrin azides. General sensitiveness of Service azide is somewhat greater. Particular attention is drawn to the grit sensitiveness of Service azide.

822 [illegible] A. R.

Mechanism and thermal processes of initiation. In ROYAL SOCIETY OF LONDON, PHILOSOPHICAL TRANSACTIONS. v. A241; 1948. pp. 240-247. Part III, section 4 of The sensitiveness of explosives.

The relation between sensitiveness to heat and sensitiveness to mechanical action has been investigated by determining the percussion sensitiveness of initiators partly sensitized by heating, and also by studying the delay to ignition as a function of the quantity of initiator accessible to the growth of the detonation wave. In these tests, lead azide was found to build up to limiting detonation conditions in considerably smaller quantities than mercury fulminate.

In grit sensitiveness, the mechanical action involves mainly the formation of hot spots between the grit and a hard surface. These hot spots acting on the initiator generate the detonation wave more easily with lead azide than with mercury fulminate.

so that lead azide is more sensitive to grit than mercury fulminate. Other mechanical effects may be present in a subordinate degree.

Percussion sensitiveness appears to be more complex, and may involve a tribo-chemical trigger reaction as well as the formation of hot spots through friction. Tribo-chemical or other mechanical trigger reactions are only indirectly related to the sensitiveness to heat since they involve a more direct transfer between mechanical energy and activation energy, than is involved if the mechanical energy is first converted into heat.

The experimental results throw further light on the build-up of the detonation wave in explosives. When the volume of explosive primarily involved in the sensitiveness phenomenon is small, as is usually the case for initiators, the mechanism of build-up differs from the self-heating mechanism which may overtake it with larger volumes of explosive.

A simple explanation is suggested for the dead-pressing of explosives, which is to be expected when self-heating is the mechanism controlling the build-up of detonation.

523 Ubbelohde, A. R. and F. Woodward.

"The effect of compression on the sensitiveness of initiators." In ROYAL SOCIETY OF LONDON, PHILOSOPHICAL TRANSACTIONS v. A241; 1948. pp. 222-237. Part II, section 2 of The sensitiveness of explosives.

The sensitiveness of the following initiators has been compared when used loose, and when compressed up to 2300 kg/cm²: crystalline Service azide (crystals 75 x 10^{-4}); powdered Service azide (fragments 1 - 25 x 10^{-3}cm); dextrinated lead azide; mercury fulminate.

Sensitiveness to heat was measured by determining the induction period at various temperatures, and also by evaluating threshold temperatures below which no detonation was observed for various masses of initiators.

Tests were also made to see how far the action of flame, and of percussion, could be correlated with the action of heat on these initiators.

Compression reduces the induction period in all cases, but the values of E and B are differently affected in the case of initiators. Compression also lowers the threshold temperature below which a given mass of initiator will not detonate. Thus in all cases sensitiveness to heat is increased by compression.

On the other hand, compression lessons the sensitiveness of mercury fulminate to flash and percussion, corresponding with the well-known phenomena of dead-pressing. If anything, compression increases the sensitiveness of lead azide to flash and percussion.

A new detonation mechanism has been observed for both service and dextrinated lead azides.

524 Ubbelohde, A. R. and F. Woodward.

"Build-up of detonation of lead azide in various media." In ROYAL SOCIETY OF LONDON, PHILOSOPHICAL TRANSACTIONS. v. A241; 1948. pp. 238-248. Part II, section 3 of The sensitiveness of explosives.

Two mechanisms have been proposed for the build-up of detonation by solid explosives: (a) In the self-heating mechanism, when heat is evolved during thermal decomposition of the explosive faster than it can be conducted away, the temperature of the mass and the consequent rate of decomposition rise more and more. Ultimately, the whole mass deflagrates more or less violently. The mathematical condition for self-heating has been formulated, but experiments show that a further condition is required for transition from deflagration, which has not yet been formulated mathematically. (b) In the mass-flow mechanism, when the gas evolved during chemical decomposition of the explosive becomes comparable with the molecular mass flow required for stable detonation in the explosive, thermal decomposition changes into detonation.

To test these mechanisms measurements of delay to detonation were made with loose masses of lead azide, both Service and dextrinated, ranging from 10 to 200 mg, using previously described apparatus.

The azides were wetted with measured volumes of liquids with various boiling points, including: water, benzene, quinoline, diethylene glycol, glycerol, dibutyl phthalate, benzyl benzoate, nujol, tricresyl phosphate, and the effect on the detonation was observed. Mixtures of benzene with nujol and with dibutyl phthalate were also investigated.

Comparative measurements were made on the deflagration of RDX in the same apparatus, both dry and with added liquids.

The effect of liquids on the detonation of lead azide, when heated, was found to belong broadly to one of two classes: (a) For liquids with the boiling points considerably below the temperature at which the test was being carried out, detonation followed after a longer delay than in the absence of liquid. There was evidence that the liquid first evaporated, and then normal detonation of the azide grains took place in the vapor phase thus formed. (b) For liquids with boiling points considerably above the temperature of test, no detonation was observed. However, under certain circumstances, a new phenomenon was observed in that the lead azide deflagrated in a manner closely resembling the behavior of the (self-heating) deflagration of an explosive such as RDX. This is quite different from the sharp detonation obtained with loose azide in air, when the masses are small. When the boiling point was in the neighborhood of the testing temperature, or with mixtures of liquids with boiling points above and below the testing temperature, both classes of behavior were observed, according to the conditions of the test. Further, the temperature coefficient of the induction period for azide wetted with these intermediate liquids suggested that detonation occurred after the liquid had been displaced by nitrogen produced by thermal decomposition of some of the lead azide. From the experimental results, it is concluded that (a) With the masses used, lead azide will detonate only when the grains are surrounded by gas or vapor. (b) Lead azide can deflagrate by a self-heating mechanism even under conditions where it will not detonate, e.g. when wetted by a liquid of very high boiling point such as tricresyl phosphate.

These conclusions support the view that the normal mechanism of detonation of lead azide is controlled not by self-heating but by some process such as mass flow. When this normal mechanism fails to operate, explosion may still occur by self-heating.

525 VonGirsewald, Conway.

USE OF HEXAMETHYLENETRIPEROXYDIAMINE FOR THE PREPARATION OF DETONATORS. 10 May 1918. German patent no. 274522.

The use of water insoluble hexamethylenetriperoxydiamine in initiators instead of lead or silver azide or mercury fulminate is described. The brisant peroxydiamine has more than 4 or 5 times the explosive power of mercury fulminate since gases are the only products of explosion. The initiating charge consists of 1 gram of trinitrotoluene and 0.05 to 0.1 grams of hexamethylenetriperoxydiamine. (mw)

526 Von Holt, Erich.

DETONATOR. May 30, 1956. Great Britain. Patent specification no. 749,727.

The construction of an improved detonator is described. The chief improvement of the subject detonator is the elimination of the cover which is usually placed between the explosive and primer charges. The removal of this cover allows the detonation impulse from the primer to reach the explosive charge without loss of energy. This, in turn, permits a decrease in the quantity of primer necessary to produce complete detonation of the main explosive charge. It is believed that a 50% cost saving can be realized due to the simple construction of the subject detonator. (vis)

527 Walker, R. V.

SAFETY DEVICE FOR ELECTRICAL DETONATORS. May 20, 1958. United States. Patent no. 2,835,877.

An improved safety device of simple, practical construction which provides protection against accidental explosion of electric detonators from electrical causes. Gives assurance against accidental shorting of the detonator lead wires and thus removes the main cause of operational failure. (vis)

528 Wayne Engineering Research Institute.

INITIATION AND FUNCTIONING OF SMALL ARMS PRIMERS, by [illegible] Hersh. April 1955. Unclassified report.

A series of five postulates have been presented, along with supporting data, as summarizing certain of the fundamentals of the kinematics of small arms primers. The application of these postulates to a weapon firing system is presented in four operational points or steps. Brief discussion is given to methods of mechanism instrumentation and calibration usable in the application of the postulates and operational points to a weapon system. It is pointed out that the Standard Drop Test Machine is a satisfactory device for use in acceptance testing of primers if the machine is properly utilized and the results properly interpreted.

529 Woodworth, L. B.

ELECTRIC DETONATOR. December 31, 1940. U. S. Patent no. 2,226,988.

An electrical detonator compris' ig an electrical circuit including a resistance to be heated by passage of electric current through the circuit, a detonating mass in a non-operative relationship to said resistance, a member positioned to be preheated by said resistance and comprising a substance the electrical resistance of which decreases when the member is so pre-heated, means for passing electric current through the preheated member and thus heating it further until it becomes activated, said member being arranged to cause detonation of said mass when activated, the arrangement being such that the activation of said member occupies a period of time substantially longer than the probable duration of any adventitious electrical condition which is likely to occur and which tends to activate said member.

530 Yerofeyev, B. V. and V. V. Syridov.

"The effects of irradiation with x-rays on the thermal decomposition of barium azide". In SBORNIK NAUCHNYKH RABOT, INSTITUT KHIMII, AN BSSR [COLLECTION OF SCIENTIFIC PUBLICATIONS, INSTITUTE OF CHEMISTRY, ACADEMY OF SCIENCES BELORUSSIAN SSR]. v. 5, No. 1, 1956: pp. 113-129.

"The effect on the kinetics of the thermal decomposition of BN_6 at 114-146° and 126° of preliminary irradiation for one hour with X rays was investigated. The duration of the exposure of the compound to X rays was varied from 0.5 sec to 50 hours. Reduction of the length of the induction period ($\Delta\tau$) and acceleration of the reaction were observed in all cases after irradiation. The dependence between $\Delta\tau$ and the duration t of exposure to radiation was found to correspond to the equation,

$$\Delta\tau = 60.0 + 13.8 \lg t$$

at values of t between 3 second and one hour. The effect of the radiation was found to be weaker for moist BN_6 and to be reduced in time after termination of the irradiation. It was established that the total energy of the thermal decomposition of barium azide diminishes after irradiation."

531 Young, A. A.

SLOW MATCH COMPOSITION. November 14, 1933. U. S. Patent no. 1,935,495.

A deflagrating composition for electric match heads consisting essentially of nitroaromatic bodies as fuels and an oxidizer taken from the group consisting of chromates and dichromates.

532 Zumbusch, Wilhelm.

ELECTRICALLY IGNITED SUPERQUICK FUZES USING A MAGNET SYSTEM AS AN IMPULSE GENERATOR. (no date). ATI no. 73091. Unclassified report.

Reports the design and method of operation of an impulse generator for electrically ignited quick acting fuzes. A small highly efficien' permanent magnet system, weighing about two ounces, is used. The impulse generator will excite an ignition voltage of 103 volts within less than 10^{-4} sec.

Applicable for all purposes requiring superquick ignition. Possible to use high velocity of a shell or bomb at the moment of impact to produce the desired motion. It is also possible to use a strong compression spring which would, upon release, produce the desired movement. The latter application could be used in demolition or dynamiting, thereby deleting the need for an apparatus requiring a source of galvanic current. (ama)

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